MACHINERY.

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NOTES FROM A LANCASHIRE MUSEUM.

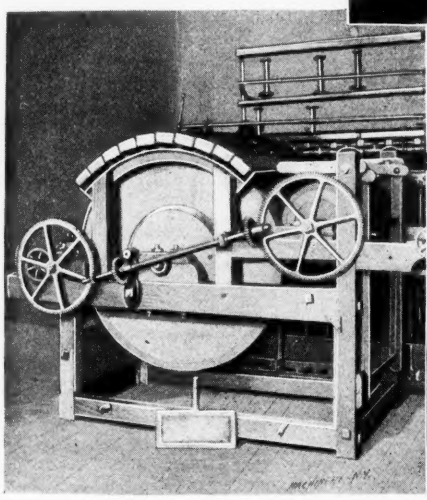
A DESCRIPTION OF SOME OF THE EARLIEST FORMS OF MACHINERY USED IN THE MANUFACTURE OF COTTON—A FEW OF THE MEN WHO LAID THE FOUNDATION OF THE PRESENT SYSTEM OF THIS INDUSTRY.

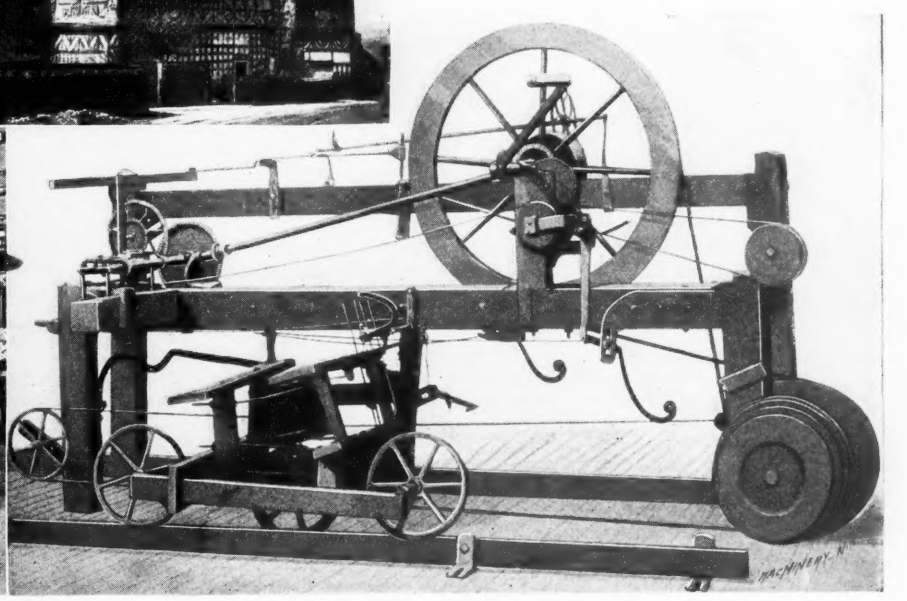
JAMES VOSE.

I was much interested recently in some specimens of early cotton machinery, etc., on view in the Mere Hall Museum, Bolton, Lancashire. The Hall itself was formerly the property of Mr. Isaac Dobson, of the firm of Dobson & Barlow, cotton machinists (a firm still in the van in its own line, though over one hundred years old), and was bought and presented to the town of Bolton as a museum and library by Mr. J. P. Thommason, a local cotton spinner. These early relics are consequently very appropriately housed. Some of the machinery was used in the oldest cotton mill in the world—Arkwright's, of Cromford, Derbyshire, England—the erection of which was the beginning of the modern factory system. The firm of Richard Arkwright & Son is still in existence and holds a very strong position in the manufacture of fine cotton yarns and sewing cotton.

It may be worth while to trace briefly the steps by which the modern method of employing power in cotton manufacture came into being, and thus revolutionized the earlier modes of carrying on most industries.

The invention of the "fly shuttle" by John Kay, of Bury, Lancashire, about 1733, caused the hand-loom weavers to require more yarn than the "throstle" or "water" frame of Arkwright, so called from being originally worked by water power (and yarn spun on modern throstle or "fly" frames is still known on the market as "water" twist), or the "spinning jenny" of Hargreaves, of Blackburn, could produce. It was then that Samuel Crompton, of Bolton, invented the "hand mule" spinning frame, so named because it combined the "throstle" was "jenny" in one. The weaving loom, almost the simplest of the various forms of cotton machinery, was one of the last of the group to be made practically perfect as a steam or water-power driven machine. Jacquard, a Frenchman, by a simple but beautiful mechanism made the repetition of complicated patterns of cloth a comparatively easy matter on the hand loom, and it was subsequently adopted on the power loom.





"HALL 'I TH' WOOD" NEAR BOLTON, ENGLAND, WHERE CROMPTON INVENTED THE SPINNING MULE.

R. ARKWRIGHT'S CARDING ENGINE.

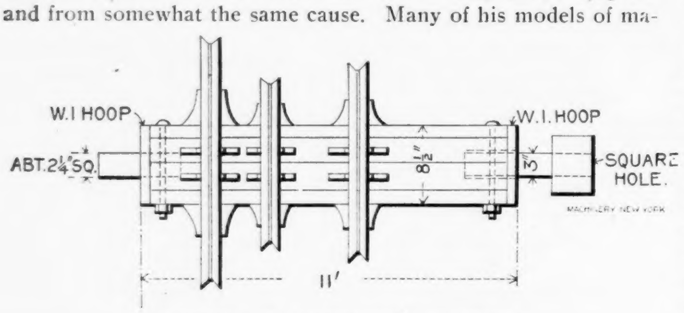
SAMUEL CROMPTON'S "HAND MULE."

It is rather curious that two clergymen should have been instrumental in the invention or improvement of looms—i. e., Lee, a Cambridge graduate, about 1589 invented the stocking loom; having been expelled from the university for some infringement of rules, he was led to investigate the subject of machine knitting through watching his wife knitting to help support the family. And Cartwright, a Yorkshire clergyman, in the early part of the present century paved the way for the introduction of the power loom. Richard Roberts, of Manchester, converted the "hand" mule of Crompton into the "self-actor" mule, suitable for coarse and medium counts. This machine, in consequence of numerous minor improvements, is now capable of spinning almost the finest counts. Besides these outstanding examples,, there were numerous and important inventions in the preparing machinery for spinning and weaving, such as the cotton gin, scutching carding, combing, sizing and warping machines Almost all these inventions were crowded into a century and with inventions in other lines kept Great Britain practically pre-eminent in manufactures.

Mr. Midgly, the curator of the Museum, kindly gave me photographs of several pioneer machines. These include a "carding engine" from Arkwright's mill, dating from about 1780; it is built principally of wood, though the wheels and other ironwork are most creditable to the mechanics of that day. Indeed, the machine as a whole is a monument of faithful workmanship, and if started up to-morrow would probably work well. A hand mule of Crompton's, which Messrs. Dobson & Barlow kindly loaned to the Museum, is one of the earliest made, and a most striking illustration of perseverance under difficulties. In this machine the root principles of the latest self-acting cotton spinning machinery can be plainly traced. The hatchet which Crompton used in the construction of the first machine is also preserved here, and an ancient specimen of the wooden hand loom is in evidence. This was built about 1710, but when the

Museum was opened in 1884 it was started up and cloth actually woven in it. A "jack" frame dated 1830, by Dobson & Barlow, is instructive, showing the progress made in systematic machine building at that date. There is about twice as much wood used in the construction of it as would be now employed. This machine was in use continuously for fifty years with practically no expense for repairs being incurred. Included in the collection is a length of the old wooden shafting which drove Arkwright's mill, of which I give a rough sketch. This shaft is octagonal in shape, and has wooden grooved pulleys built on it. The ends are hooped with wrought iron, and have wrought iron gudgeons, or arbors, bolted in. The method of coupling the lengths of shafting is certainly positive enough.

Lancashire has a goodly roll of pioneers to its credit, but its treatment of some of them during their lives is a disgrace to the county. John Kay was driven to France and died in needy circumstances. Some of his direct descendants, with whom I am acquainted, have scarcely any idea who or what their ancestor was. One of the youngest of them is an apprentice in a cotton machine works, and may learn of his ancestor if he attends the Bolton Technical School, and only a few years ago a direct descendant of Crompton was working as a journeyman mechanic at Dobson & Barlow's. To read how Crompton, a man of the loftiest character, was fleeced and buffeted about by unscrupulous "business" men, because his refined nature would not allow him to compete with them in their methods, tends to give one a poor opinion of human nature. He also died in poverty. Mr. Midgley included among his photos one of "The Hall i' th' Wood," the residence where Compton constructed his first machine. The building is still used as a farmhouse. Richard Roberts eventually came to the same end as Kay and Crompton, and from somewhat the same cause. Many of his models of machinery are preserved in the Peel Park Museum, Salford, Manchester. Arkwright, who originally kept a barber shop in Bolton, was essentially a business man, as well as an inventor, and, not being troubled with fine scruples as to appropriating other men's ideas, "made his pile" to a very satisfactory extent. John Dalton, the eminent chemist; Joule, the promulgator of the theory of the mechanical equivalent of heat; Bodmer, Fairburn and Whitworth were also largely identified with, or natives of, Lancashire, and perhaps later on I may be in a position to present some personal recollections of the latter mentioned men, given by a gentleman who, when a young man, had personal dealings with them.



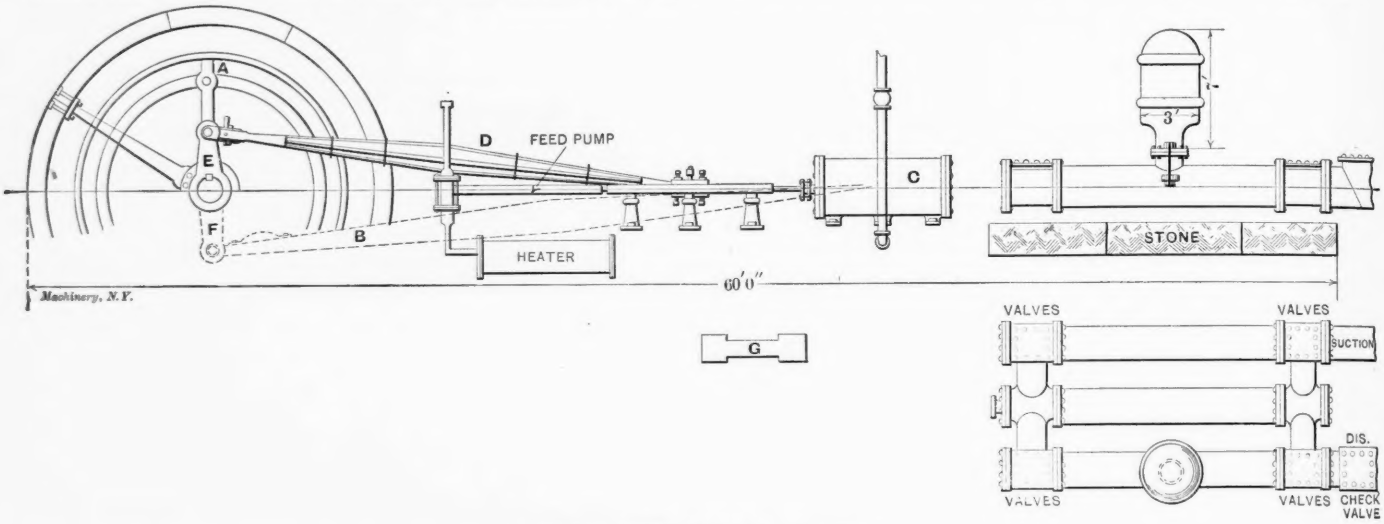
A LENGTH OF ARKWRIGHT'S SHAFTIFG.

AN OLD PUMPING ENGINE.

JAMES T. FINK.

Having some work to do on a new pump that was being erected in one of the cities of Virginia during the summer, I came across an old-timer in the way of a pumping engine, which was quite a curiosity to me and which I shall attempt to describe by aid of the sketch and a few notes that I made at the time. The pump is driven by steam or water power, as required, and is double acting, the barrel being 10 inches in diameter with a piston packed with hemp packing, which they renew about once a month.

As originally designed, the power to run the pump was obtained from a tail race driving an overshot wheel 20 feet in diameter and making nine revolutions per minute. On the end of the wheel shaft, which projects through the wall of the building, is an open disk crank, marked A in the sketch, to which the pump piston is attached through the cross head and connecting rod in the usual manner. This connecting rod is represented by the dotted lines at B, and is shown attached to the crank, by which it is driven when running by steam power. When running by water power it is attached at A. The rod is of wood, 5½ inches thick by 15½ inches wide in the center, and tapering to the ends.



AN OLD TIMER DOWN IN VIRGINIA.

On the edges of this rod are iron straps ½ inch by 4 inches, running from end to end, to which are welded the stub ends, and which are held in place by bolts through the rod. The length of this rod is 30 feet between centers, and the stroke of the pump is 9 feet, or 18 feet per revolution, making the capacity of the pump about 1,000,000 gallons in twenty-four hours, against a pressure of 58 pounds per square inch.

This pump was built and erected in 1851 by I. P. Morris, of Philadelphia, and has been running almost continuously since that time, and now looks as if it might run for many years more under the same conditions.

The water supply for the pump is taken from the tail race, which also drives the water wheel, and after the erection of the pump it was seen that there would not be water enough during the summer months to keep up the work. They had to look for other means for driving during this time, and therefore a steam engine was designed, built and erected by Thomas Jameson, of Alexandria, Va., in the year 1855, which I will describe as follows: The steam cylinder marked C is 12 inches diameter, with a D slide valve connected to the eccentric through a rock shaft and having a hook end on the rod, which can be thrown out and a bar used for starting and stopping the engines.

The connecting rod D is made of six 1-inch square iron bars, welded onto stub ends. On these bars are placed five plates with square holes spaced equidistantly and of a size to fit the rods. The plates cannot move either way on account of the taper of the rod, and seem to make a substantial rod for this engine. The length of the rod is 16 feet between centers.

The crank-shaft is 8 inches diameter, with a wrought iron crank on each end set at 180 degrees, as shown at E and F, and with a 20-foot flywheel in the center. The hub of the wheel is keyed on to the shaft, the spokes are bolted to the hub, and the segments, of which there are eight, are held in place by six 1-inch

countersunk head bolts, and in addition to the bolts, a key, as shown at G, is put in at each joint, making a substantial job.

While the stroke of the engine is just one-half that made by the water-wheel crank, A, it makes twice the number of revolutions per minute, giving the pump about the same capacity by water or steam.

It will be seen by the dotted lines that the wooden pump rod is connected to the crank shaft of the engine, as drawn, and to change to water power, which they utilize from December to April, they attach a rope to the handle, shown by dotted lines, disconnect the rod and raise to the pin at A, after which the pin in the crank is removed, it being held in place by nuts.

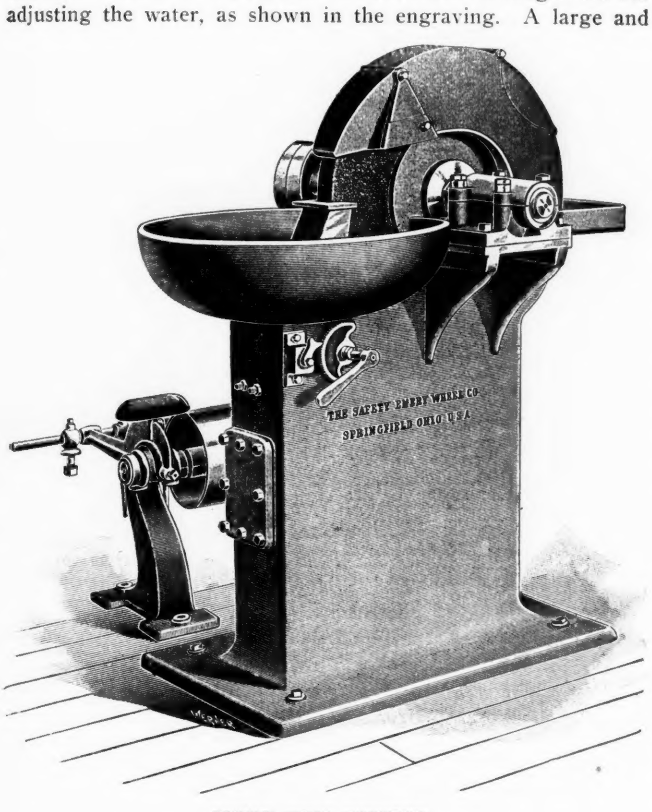
I did not inquire what effect the barnacles in the pump barrel had on the packing when changing from steam to water power and increasing the length of stroke, but I suppose it is bad enough. The space occupied by this engine and pump is 12 feet by 60 feet, being quite a large space for a pump of 1,000,000 gallons' capacity.

The steam supply for the engine is furnished by two 42-inch flue boilers, 20 feet long, carrying 80 pounds pressure. These boilers have been in use since 1871. The steam pipe passes around the cylinder and enters the steam chest at the bottom. The exhaust passes out through the heater, through which the water is pumped to the boiler by the feed pump, as shown on the side of the engine.

* * *

A NEW EMERY TOOL GRINDER.

The Safety Emery Wheel Co., Springfield, O., have placed an emery tool grinder on the market, an illustration of which is shown herewith. It was designed with a view of incorporating in one machine all the desirable features that the long experience of its builders could suggest. It has sufficient weight to insure a solid setting, with large spindle and long bearings, which are self oiling and dust proof. There is a large water chamber under the wheel, with a convenient arrangement for adjusting the water, as shown in the engraving. A large and



EMERY TOOL GRINDER.

deep bowl is provided to prevent slop on the floor, and it is of circular shape, so that the wheel will be within convenient distance of the workman, whether he stands in front or a little to one side of the machine. The bowl is fitted with an adjustable rest. Balancing collars are provided and the back of the hood is arranged to open to allow long pieces to be ground that cannot be brought into position at the front of the wheel. The machines are made, either with countershaft or with tight and loose pulley on the spindle.

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

NINETEENTH ANNUAL MEETING – PRESIDENT HUNT'S ADDRESS – BRIEF MENTION OF PAPERS PRESENTED–THE NEW PRESIDENT, COMMODORE GEORGE W. MELVILLE.

The annual New York meeting of the American Society of Mechanical Engineers was held from Nov. 29 to Dec. 2 at the house of the society, 12 West 31st street. Officers were elected for the ensuing year and another distinguished name was added to the list of presidents in the election to the presidency of Commodore George W. Melville, engineer-in-chief, U. S. N. A sketch of Commodore Melville's life will be found in another column of this issue.

Although there were several noteworthy papers presented, they were not as attractive or valuable as usual, when taken as a whole, though they drew out an unusual amount of interesting discussion. Besides the regular papers, a list of which follows, was a report of the committee on a standard code for steam boiler trials, which, however, was finally held over until the spring meeting for action by the society. The council reported, among other matters, that a committee had been appointed to consider and report upon " Standardization or Unification of the Methods of Testing Steam Engines," as ordered by resolution at the Niagara Falls convention; and that a committee had also been appointed to consider the subject of standard pipe unions.

President Hunt's Address.

The address of the retiring president, Mr. Charles Wallace Hunt, was given at the opening session, on the evening of Nov. 29. Mr. Hunt spoke of "The Engineer, His Work, His Ethics, His Pleasures." He started with Tredgold's definition of an engineer as " one who is skilled in the application of the materials and forces of nature to the uses of man," and considered in a general way the training and work of the engineer, commencing with the college and including his later industrial life. He touched upon the rapid advances that have been made since the advent of the engineer and outlined the remarkable results of his research in the following words, which sum up the status of the best engineering practice in a striking manner.

He tests his materials with painstaking refinement. He measures electric resistances with an accuracy now reaching the point of one in four millions—time to the one-millionth part of a second;—divides a circle with a mean error not exceeding the one-millionth part of the circumference;—makes surfaces six inches square with a variation from absolute flatness of less than one two-hundred-thousandths of an inch, and parallel within one second of arc;—rules lines which vary from absolutely perfect spacing by only one three-millionth part of an inch—measures his optical work with a wave-length of light as a unit of distance, and handles this unit of the one forty-thousandth of an inch as easily as a mechanic handles a rule;—see clearly the spectrum of samarium when one part is diluted with three million parts of lime;—and surveys lines eleven miles long, in the open air, with an average variation in three measurements of only four-tenths of an inch.

Regarding engineering practice, Mr. Hunt said:

The engineer of the user and the engineer of the maker have widely different duties. Consider how different may be the information required in practice by two classmates, whom we will designate as "A" and "B," who graduate from college as engineers. We will suppose that "A" secures a position in the engineering department of a city, and commences his work, which may be the designing of a new water-pumping station. His college course has fitted him for the work. His text-books were suited to problems of this character. He finds abundant information on all branches of the subject, in data published in the proceedings of scientific societies, in technical literature, and in annual reports of city departments. The forms of contracts to be entered into are at hand, all found elaborately drawn, with every point safe-guarded, and need only a little selection and adaptation to suit his case. They place in his hands the power to decide absolutely and without appeal all question which may arise in carrying out the work.

"B" obtains employment in the engineering department of a manufacturing corporation, which in due time is to submit a tender for the construction of the pumping plant for which "A" has issued specifications. He will find that the form of contract

proposed by "A" has many minute and carefully worded clauses to bind and limit the supplier. The tender to be submitted for the execution of the work must in its scope and wording protect the interests which "B" represents, not only in a general sense, but in every one of the clauses of the proposed contract. Every obscure phrase and every adjective used by "A" must have definite consideration and be clearly defined in both an engineering and a legal sense. "B" here finds that the information derived from his college course is meagre, and there is no technical literature which he can use, either as a general guide for making a form of tender, or the proper expressions to use to define or limit the obscure clauses or words found in the specification.

Looking at the subject from a purely technical point of view, we see quite as great a variation in their work. In the case supposed, "A" would require only a general knowledge, while "B" would require the most thorough and exhaustive information of the qualities of constructive materials, and shop practice available in that particular location. The farther we carry the comparison of their work, the more clearly it is seen that the educational needs are becoming more and more complex, to correspond with the growing specialization of engineering work.

There is another phase of engineering practice represented by the duties of "A" and "B" which now becomes interesting, if the work of American engineers is to take the place in the world at large to which the indications now so plainly point. In other countries it is a common practice for "A" to make all the general designs and all of the details for engineering work, and the supplier has no responsibility for either, or for the efficient working of the plant when completed. If errors or omissions are found in the drawings or specifications, the cost of the changes required is paid by the purchaser, in the usual bill for extra work. In this case, the duties of "A" are exhaustive, and those of "B" are small or disappear altogether.

The American practice is tending to the method of making the requirements issued by "A" of a general character which will cover the results sought, and leave to the supplier, "B," the work of designing the particular means to accomplish the desired end. Business has become of such a magnitude and so complex that one mind cannot fully grasp and readily handle the new discoveries, new materials, and new practices which now come so rapidly. For efficient and economical results, each phase must be handled by an expert.

There will be many "B" engineers to respond to the requirements of "A," and each will present for consideration different ideas, different materials, and different shop practices. "A" must select, from these various plans and details submitted, the one which best promises to fulfill the requirements. It is a division of labor between "A" and "B," each of whom, by tastes and training, is especially fitted for his part of the work. We may paraphrase their duties by saying that "A" is a judge, "B" is a counsellor.

At the present time we cannot expect our technical schools, painstaking and perfect as they are, to fully prepare both "A" and "B" for such new and varied duties, or even to have their instruction in engineering fully abreast with the latest practice, or at least not until progress in the arts and sciences has substantially ceased. It takes time for a new practice or a new result to be recorded, published, considered, and adopted by the teaching staff.

The difference between the teaching and the engineering practice of the day is not only an indication of progress in engineering, but in some measure is an index of its rate. The student, then, must expect, as a normal proceeding, to supplement his graduating acquirements by practical experience, together with a personal contact with his professional brethren, in order to place himself fully abreast of the times, and to be fitted for the most effective and useful engineering service.

The Papers.

A "Note of the Strength of Wheel Rims," by A. K. Mansfield, was one of two papers upon fly-wheels which brought out considerable discussion, including an account, by Mr. John Fritz, of his extended experience in designing and constructing fly-wheels. Mr. Mansfield's paper was very brief and showed that ribbed sections for fly-wheel rims having the same amount of metal as those that are not ribbed, might be either stronger or weaker than the latter, according to the design. Mr. Mansfield's plan is to use a very deep rib at the centre of the rim, which brings the neutral axis of the section well within the inside of the rim. The other paper upon fly-wheels contained the results of very complete fly-wheel experiments by Prof. C. H. Benjamin. This paper was highly commended, and is reprinted nearly in full in this issue.

A paper by Prof. C. V. Kerr upon "Theory of the Moment of Inertia" was intensely mathematical and combatted the common theory and definition of the moment of inertia. The sense of the discussion was that the old definition and theory were so inseparably connected that any new deduction should have a new name to avoid confusion. W. Barnet Le Van followed with a paper upon improvements in boilers and settings, which contained a description of the author's boiler and setting, an account of which was given in the March, 1898, issue of MACHINERY.

A paper by R. Van A. Norris was exceedingly interesting in showing what may be done in the way of improving an old plant by adopting systematic tests and going to the bottom of things. It contained a very full report on the results of tests made at two collieries in the coal regions of Pennsylvania, one owned by the Lykens Valley Coal Company and one by the Summit Branch Coal Company. The aggregate boiler horse-power of the two collieries was about 8,500. It was found that steam was used extravagantly at both plants, some engines being so lightly loaded as to cut off at 5 per cent. stroke, others carrying steam full stroke, steam blowing off through leaky joints and drips, traps conspicuous by their absence, pumps using 60 pounds of steam per horse-power per hour, when compound pumps would have used only two-thirds as much, and so on to the end of the chapter. In one plant 13 per cent. of the steam could not be accounted for, which was not taken to indicate excessive leaks; but in the other this loss amounted to 38 per cent. The results thus far have been the shutting down of 26 boilers through re-setting engine valves, stopping leaks, etc., and Mr. Norris estimates that if all the old machinery could be thrown out, and new substituted, the saving would be $40,000 per year.

The next paper described the well-known Willans valve gear, and was presented by John Svenson. This gear is doubtless familiar to most of our readers.

"A Cooling Tower and Condenser Installation" was the title of a paper by J. H. Vail. It gave an account of the installation of a Bernard cooling tower to make it possible to run the engines of a large electric light station condensing. The boiler plant had been working up to its full capacity and this plan was adopted in lieu of adding more boilers and increasing the size of the station. The result was an increase of 1,000 horse-power, with boilers to spare. This paper called out a long discussion by Mr. F. M. Wheeler.

Prof. D. S. Jacobus presented the next paper upon "Methods of Testing Indicators," in which he advocated a method that he thought superior to testing by mercury column. Of this, we hope to say more in a later issue.

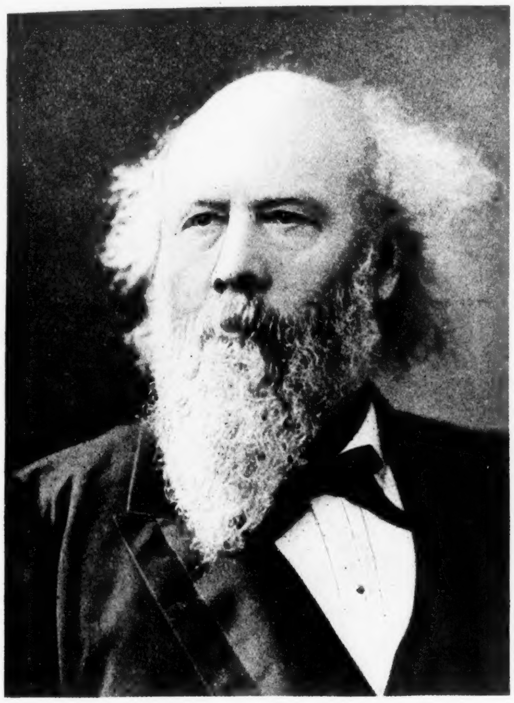
Prof. W. S. Aldrich brought up the question of belt tensions, and deduced a formula from the experiments of Wilfred Lewis made several years ago, to take the place of the ordinary logarithmic formula. Some of his conclusions were disputed by Mr. Lewis, and Mr. Barth, who was formerly with William Sellers & Co., gave a complex formula of his own, which is interesting to students of mathematics.

The "Calorific Power of Weathered Coals," by R. S. Hale and Henry J. Williams, gave results of tests on samples of coal that had been exposed to the weather 11 months, and samples of the same coal that had been kept in a sealed jar during the same length of time. The general conclusions were that there was a slight diminution of calorific power in the grades of coal examined, directly traceable to weathering.

The next paper, by W. H. Bryan, upon the "Mechanical Plant of a Modern Commercial Building," was the fore-runner of what will undoubtedly form a frequent subject for discussion in the future. The paper was exhaustive, and dealt with the installation of the boilers, engines, dynamos, elevators, heating systems, etc., in a large building in St. Louis. The discussions which followed were carried into the details, and when the paper and discussions are both printed they will form a most valuable fund of information upon this timely subject.

A paper by Prof. R. C. Carpenter was read upon "Experiments on the Flow of Steam Through Pipes," which, with the discussions, will make a valuable addition to the information on this subject, and may assist materially in proportioning steam piping. The last paper was read from manuscript by Chas. L. Newcomb, upon the flow of streams from fire hydrants.

COMMODORE GEORGE W. MELVILLE, THE NEW PRESIDENT.



From the beginning of the sixteenth century the name of Melville has been associated with the history and romance of Scotland; the men of the race have ever been noted for their brave words and braver deeds, and from this long line of ancestry comes George Wallace Melville, Engineer-in-Chief of the United States Navy.

The father of Commodore Melville first saw the light in the ancient home of the family at Stirling, Scotland, but he himself was born in New York city, January 10, 1841. He was educated in the public schools and later showing marked mechanical instincts, passed through the Polytechnic School of Brooklyn, taking a further course in mathematics in a religious academy of the same city. School days ended, he entered the engineering works of James Binns, of East Brooklyn, and there laid the foundation of that practical skill which has since served to make him famous.

With the outbreak of the Civil War young Melville, then in the dawn of manhood, devoted to the country of his birth, and with the blood of the stern race from which he sprung stirring in his veins, was caught in the wave of loyalty which surged over the country, and on July 29, 1861, though but twenty years of age, became an officer of the Engineer Corps of the United States Navy. The great work accomplished by the naval engineering force during the war every record of that time has taught us; the blockade was one of the main factors in ending the civil war, and the success of this measure was mainly due to the skill and patriotism of the Northern engineers. Had they not been ready at their nation's call—had they not come, as Melville came—the war would have been greatly prolonged, or might even, with the aid of outside foes, have resulted in disaster.

Although but a junior officer, Melville saw much active service during the war. He was for a brief period on the Michigan, cruising on the Northern lakes, and was transferred thence to the sloop-of-war Dakota, serving with her during the shelling of Lambert's Point and the capture of Norfolk. The young officer was attached to various ships, and was a member of the staff of the Wachusett at the time of the capture by that vessel of the Confederate cruiser Florida, in the neutral waters of Bahia harbor, Brazil. His advice was largely instrumental to the success of this enterprise, in the carrying out of which he displayed the utmost bravery, winning thereby the honor and affection of every member of that gallant crew. Leaving the Wachusett, Melville volunteered in answer to Porter's famous call, and was assigned to torpedo boat No. 6, serving with Porter's fleet at the capture of Fort Fisher and the subsequent hazardous duty of clearing the channel of the Cape Fear River that the fleet might advance to Richmond.

At the close of the war Melville was attached to the Tacony, and, with her, served in the Gulf of Mexico during the occupation and evacuation of Mexico by the French. Later he joined the Penobscot; then in the flagship Lancaster cruised to Brazil; then to the Arctic on the Tigress; then to the Orient in the Tennessee; again to Arctic waters in the Jeannette, and yet again, in the Thetis, for the relief of the Greeley expedition. This last duty, with the exception of a short term on the Atlanta, closed his services afloat. It is scarcely necessary to add that during his cruising Melville was commended officially in more than usual form by senior and commanding engineers.

Perhaps the most thrilling part of Commodore Melville's career is that during which he was connected with the several Arctic expeditions. His first trip to the frozen North was in 1873, when, as engineer officer of the little sealing steamer Tigress, he assisted in the search for the remaining members of the crew of the unfortunate Polaris. The story of the Jeannette is too well known to need repetition here; the tragedy of that ill-fated expedition is yet too fresh in our minds. It is worth while, however, to glance over the record of Melville, the engineer officer of the Jeannette. It was only through his skill and energy that the vessel avoided foundering in the beginning, and she would have been abandoned long before she sank but for his inventive genius and resources. He it was who led the working force during that awful march across the ice floe, and he commanded one of the three boats during the subsequent retreat, being the only commander to bring his crew safely through. While still enfeebled from his terrible experience he made a search without equal in Arctic history, for De Long, through the wild storms and deadly cold of the Arctic winter. In the early spring he found and buried his dead comrades, and though still ill and partly frozen, recovered and brought back all the records of the expedition.

Melville's achievement in this expedition, retreat and search met with cordial acknowledgment from competent authorities and the Naval Court of Inquiry, which in 1883 investigated all facts as to the Jeannette expedition, stated in its report that especial commendation was due to him for his zeal, energy and professional aptitude.

After Melville's return his friends in Congress introduced a bill advancing him thirty numbers and giving him the thanks of that body. The measure was bitterly fought and was passed only after a delay of ten years, and then in a modified form, advancing him only fifteen numbers and omitting the "thanks."

Melville reached home in September, 1882, just a year after the parting of the boats in the Arctic seas, but the spring of '84 saw him once more on his way to the North, this time with the squadron dispatched to the relief of the Greeley expedition, the feeble and starving remnant of which was rescued in June, 1884, by the United States ships Bear and Thetis.

Commodore Melville has served as engineer-in-chief of the United States Navy for eleven years. The term of his office is four years, and that he is now serving his third appointment indicates the national appreciation of his worth. During the years that he has been the engineering head of the Navy, up to a year ago, machinery aggregating over 350,000 H.P. has been designed for some sixty vessels, ranging in type from a battleship to a torpedo boat, and he has passed upon expenditures approximating thirty millions of dollars without a question as to his efficiency or a suspicion as to his integrity. Since that date these figures have greatly increased,

He began his duties as engineer-in-chief at the time when the only modern steel vessels of the navy was the original John Roach ships of the white squadron, having a speed of from 14 to 16 knots. From this small beginning, in the short space of a decade, has grown our victorious navy, which includes the fleet 22-knot Columbia, Minneapolis and Olvmpia, as well as the famed Oregon and other vessels of her type. The cruis-

ers Columbia and Minneapolis were the first vessels of large size in the world to be propelled with triple screws, and stand as an example of the advanced ideas held by Commodore Melville, which, however, have invariably come within the bounds of safe engineering. The most recent work of note that he has accomplished has been upon the machinery of the Maine and sister ships. These vessels, battleships of the heaviest class, are to have a speed of 18 knots, with a large radius of action, thanks to the persistent efforts of Commodore Melville.

The engineer-in-chief is an eloquent speaker, and though like many men of action, he has written little, preferring to leave the record to others, his book, "In the Lena Delta," proves him no amateur in the field of authorship. In speech he is quick and decisive; reticent of his own deeds, he is ever ready to ackowledge achievement in others, and, like strong men before him, is wholly straightforward. Personally, Commodore Melville would attract attention anywhere; his height is but a trifle under six feet, and his erect, stalwart frame is surmounted by a massive head, with hair and beard grown white in active service.

Mr. Melville is a member of many societies, both here and abroad, and has had numerous honorary titles conferred upon him. By act of Congress he became a gold medalist for heroic service in the Arctic; he is an active member of the Grand Army of the Republic, of the Naval Order of the United States and of the Loyal Legion, a military order which has shown him much distinction. The American Society of Mechanical Engineers may well feel honored in its new president, a feeling that is doubtless reciprocated by Commodore Melville.

* * *

TYPICAL EUROPEAN MACHINE TOOLS.—2.

VERTICAL MILLING MACHINES.

Some cuts of vertical milling machines designed and built in Europe are presented on a full-page illustration of this issue. The vertical spindle milling machine is built in Europe in both the plain and universal types, and in a great variety of sizes, as will be readily seen from the illustration. Aside from what may be termed the planer type of vertical milling machine (so named because the general outline resembles that of the planer), designs of the types presented are little used here compared to the extent one meets them abroad. The Becker milling machine forms a notable exception.

The great overhang of the part carrying the spindle in connection with the circular table seen in the larger sizes adapt them well for milling circular grooves in large pieces. These machines are also mostly fitted out for milling irregular surfaces to templates. Here we generally overcome the necessity for the latter arrangement in avoiding designs of irregular shaped pieces. The smaller sizes of vertical milling machines are mostly of the universal type and aside from the superstructure carrying the spindle, resemble the horizontal machine in nearly every particular. They are mostly used for surface milling, and the cutters preferably employed are of the shank type, of small diameter, with spiral teeth of rapid twist, the angle of the spiral with the centerline of the cutter being as high as 30 degrees.

C. C. S.

* *

There is a movement under way in Boston for a supply of cheap fuel gas at the rate of seventy-five cents per 1,000 cubic feet. The Brookline Gas Light Co. is interested in the scheme, and, according to the statement of their president, Mr. Henry M. Whitney, the cost of power at this rate will amount to only 1 1-5 cents per horse-power per hour for engines up to 100 HP., and less for those of larger size. It is with engines of small power, of course, that the greatest advantage in having cheap gas fuel would be derived. Assuming that the average small engine uses from 6 to 10 pounds of coal per horse-power per hour, it is estimated that the saving in fuel alone, without considering any of the attending charges, or the relative first cost, would average from nothing at the 6-pound rate to four-fifths of a cent per horse-power hour at the 10-pound rate for coal. According to these figures it would be cheaper to use the gas engine for small powers and for medium powers just as cheap and probably more convenient, assuming that the exhaust steam could not be used to advantage, as is likely to be the case with small powers in the city.

LABORATORY INSTRUCTION.

The Massachusetts Institute of Technology has issued a pamphlet upon the department of mechanical engineering at that institution. It is of special interest, because this school has from the first made a feature of laboratory work, and is, in fact, the pioneer in that direction, and there are a number of illustrations and diagrams showing the equipment of the engineering laboratories, which have recently been enlarged.

Taking this as a typical school, with equipment and instruction of the most advanced type, the following list of experiments will be of interest, especially to our English readers, as showing what is now accomplished in the way of laboratory instruction in this country. It is taken from the pamphlet mentioned and comprises the experiments and tests made by the students in regular class work during the past two years:

Tests of the transmission of power by belting; of the performance of a surface condenser; of a direct acting steam pump; to determine the accuracy of planimeters; to determine the accuracy of indicator springs; of a 36 H.P. gas engine; to determine the efficiency of jackscrews; to determine the efficiency of pulley blocks; of the flow of steam.

Valve-setting (plain side valve)—Tests of a pulsometer and of a centrifugal pump; calibration of orifices for the flow of water; determination of the clearance of an engine; use of the Emerson power scale. Valve-setting (double valve)—Tests of gauges by means of the mercury column.

Tests of a 208 H.P. boiler, the test continuing for 104 hours, each man working eight hours.

Tests of the steam injector; use of three different kinds of calorimeters; tests of a Swain turbine; tests of a rotary pump of a capacity of 1,000 gallons per minute.

Measurement of the flow of water by means of orifices and weirs; test of a 48-inch Pelton water wheel; tests of a Rider and of an Ericsson hot air engine.

Valve-setting (Harris-Corliss engine)—Analysis of chimney gas.

Explosive force and time of reaching maximum pressure of different mixtures of gas and air; ratio of specific heats of air; tests of a battery of boilers of 200 H.P., each test lasting twenty-four hours, each student working eight hours; application of Hirn's analysis to the triple expansion engine in the laboratory, run as a compound engine.

Forty-five-hour test on the engines, boilers and generators at the Harvard Square power station of the Boston Elevated Railway Company, with four watches, each of eleven and a quarter hours, by a squad of twenty-five students.

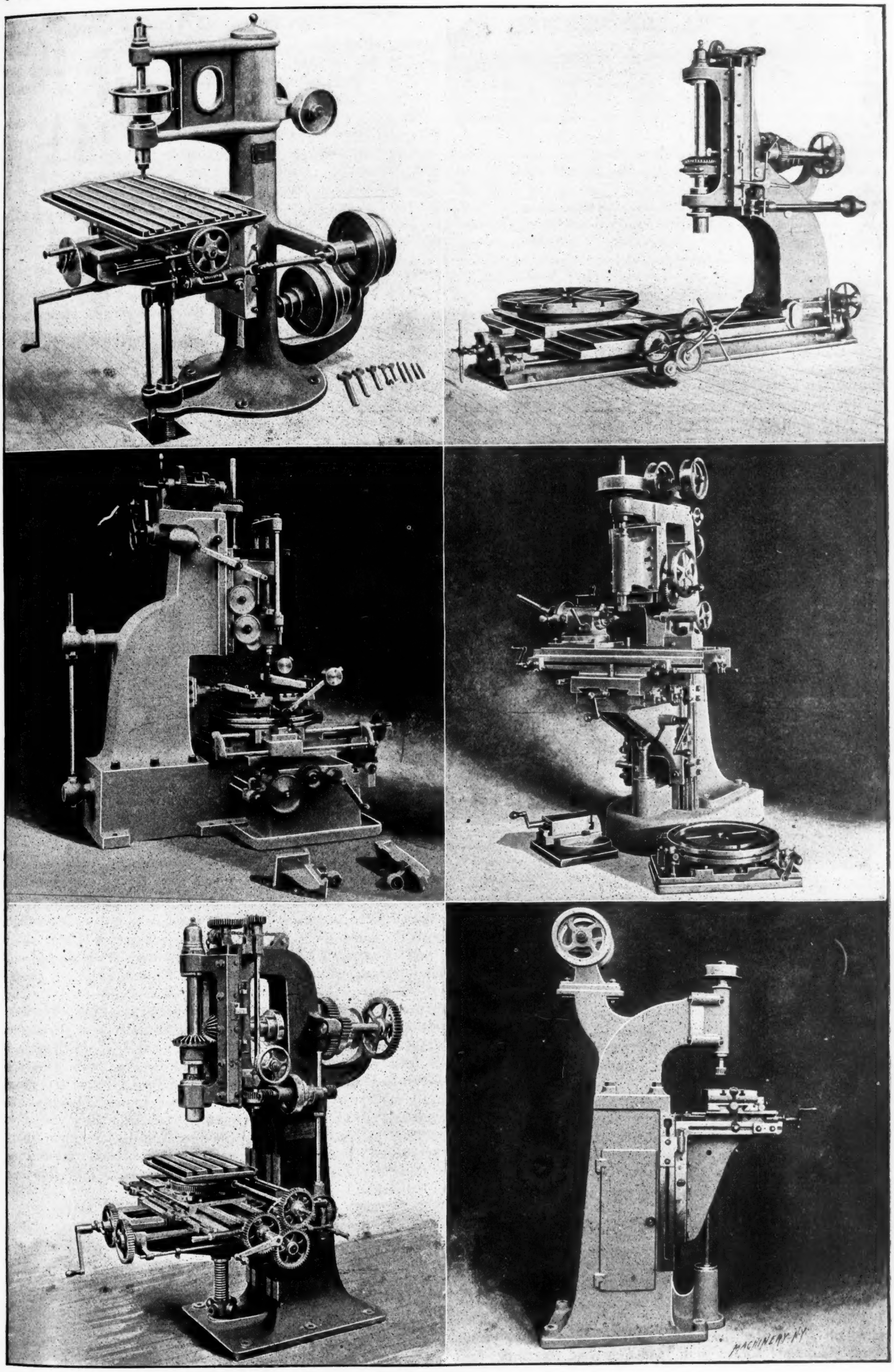
Another long list is given, also, showing the character and extent of the work done in testing the strength of materials. Like the other, it includes the work of two years, and is as follows:

Tests to determine:

1. The modulus of elasticity, the limit of elasticity, and the tensile strength of cast iron, wrought iron, or steel rods or bars.
2. The strength of full-size timber trusses.
3. The modulus of elasticity, and the tensile strength of annealed or bright iron wire.
4. The shearing modulus of elasticity, and torsional strength of two-inch iron or steel bars.

Tests of:

1. The tensile strength of hydraulic cement.
2. The compressive strength of hydraulic cement.
3. The tensile strength of compositions.
4. The deflections, and of the transverse strength of full size iron or steel I-beams, or of wooden beams, subjected to transverse loads.
5. The strength of cast iron water pipes up to 48 inches diameter.
6. The compressive strength of wrought iron pipe columns.
7. The tensile strength of bolted joints.
8. The strength of different kinds and sizes of ropes, and of different knots used in fastening ropes.
9. The strength of twine, window cord, belting, and belt lacing.
10. Torsional tests of composition bars; of iron, steel, brass, and copper wires.



TYPICAL EUROPEAN MACHINE TOOLS—VERTICAL MILLING MACHINES.

COMPOUND TRACTION ENGINES.

THE CONDITIONS TO BE MET—THE OBJECT OF COMPOUNDING—DESCRIPTION OF TYPES.

JOSEPH B. HALL

In compounding traction engines, conditions manifest themselves that differ from those that occur in compounding automatic engines; and, though it could be done, it is not advisable to attempt to reach the same degree of efficiency obtained in compounding automatic engines for the following reasons: The engines do their work in situations usually some distance from repair depots and railway stations, making it difficult to obtain repairs quickly. A threshing crew of twenty or more men at high pay may be rendered idle for some days, and the grain waiting to be threshed become unmarketable, all owing to some break in a minor part of an engine. So efficiency must needs be—at least in some respects—subordinate to simplicity and durability.

Lightness of weight is another requisite, as the bridges in most every part of the country are too weak to sustain the weight of the larger engines. In the Northwestern States, where the desirable size is 25 nominal H.P., it is almost an absolute necessity to use a compound engine, as a 20 nominal H.P. simple engine is about as heavy as the bridges will sustain. As mentioned hereafter, the boiler used with a 20 H.P. simple engine will readily supply steam for a 25 H.P. compound. The difference in weight between the simple and compound being but a few hundred pounds, caused by the additional cylinder, larger shafts and gears, while a 25 H. P. simple engine would weigh a ton or so more than a 20 H. P. simple engine.

Some traction engine builders have said that nothing better could be done than to follow locomotive practice Up to a certain point such a course is desirable, but there is a line of demarkation. No locomotives have to surmount such grades nor are railroad engineers required to govern the direction of their course, as are done with a traction engine. The latter being fitted with a friction clutch, which operates the traction gearing, and is thrown in after the engine proper has got up to speed, does not need to produce the starting effort that a locomotive has to do. So the disadvantage of having but one simple cylinder or tandem compound cylinders is not great; for the chances of the engine stopping on its dead centers are nullified if the reversing lever is brought to the center notch on the quadrant as soon as the steam is shut off before the engine ceases running.

Though compound traction engines are used all over the country, they are chiefly to be found in the Northwestern States often in combination with straw-burning boilers. In that district the necessity for compounding was first manifested, owing to feed water in many instances having to be hauled for miles by teams. When the first demand for them was made, some manufacturers were sufficiently progressive and had already built compound engines, while others were fairly forced into their manufacture by their customer's importuning.

To a great extent the aim in compounding traction engine cylinders is to obtain the efficiency of a simple engine cutting off at one-fourth stroke, and yet permit the full boiler pressure to be applied for three-quarters of the stroke in the high pressure cylinder, enabling a start to be made from any point of the stroke except at dead centers.

The bores of typical compound traction cylinders, 6 inches diameter for high pressure, and 9 inches diameter for low pressure, serve to indicate that their ratio of expansion at full gear (three-quarters cut off on high pressure cylinder) is about the same as that of a simple engine at one-quarter cut off. When the valve gear is "hooked up" expansions of six or eight times can be obtained.

Numerous losses occur under the conditions the engines are operated, of which the chief are: Back pressure, consequent upon maintaining a forced draft, and excessive clearance, resulting partly from the needs of the case and partly from the use of a single steam chest and valve in compound engines.

The maker's rating of traction engines is arbitrary, as the engines in full gear (three-quarters cut off, in simple cylinders) develop 200 per cent. of their nominal rating, plus about five H.P., as a usual thing; for instance. an engine rated at 18 H.P. will furnish 43 actual H.P. under brake test.

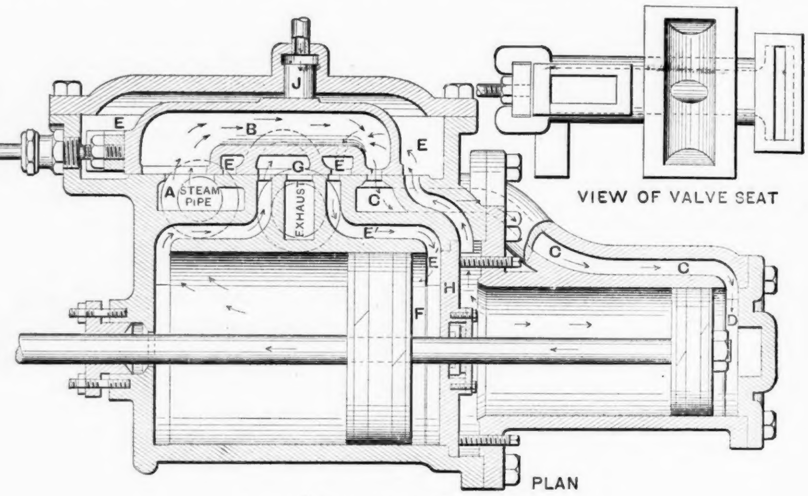
The gain in H. P. with the same coal and steam consumption, and same boiler and pressure, by using compound cylinders, can be readily seen by reference to the following quotation from "Haswell,"—assuming that nothing is gained by the cylinder losses being diminished by using two cylinders, and that the ratio of expansion is equivalent to one-quarter cut off in a simple cylinder. This table assumes that the conditions under which consumption takes place is the most favorable:

Per cent of stroke at which steam is cut off ..	1.00	75	50	37.5	33	25
Lbs. of steam consumed per HP. hour.......	34	26.9	21	18.5	17.6	16

As higher boiler pressures are desirable and advantageous in compound engines, a further gain in power with the same steam consumption is obtained.

Description of Types.

The "Reeves" is a cross compound with cranks set 90 degrees apart, with two valves and steam chests. The "Marion" has the high pressure cylinder above the lower, with both piston rods connected with a single cross-head and connecting-rod, with two valves and steam chests. The "Advance" and "Russell" are tandem compound, with two valves and steam chests. The "Woolf" is built by many manufacturers, a plan of which is shown in the illustration: A is the high pressure steam entrance from boiler, from which it enters the valve passage B, which is practically the high pressure steam chest; steam appears to be admitted into high pressure cylinder D through port C; while the high pressure exhaust enters steam chest E, which acts as a receiver. From thence the steam passes into low pressure cylinder F through port E', while the low pressure exhaust passes out into smokestack through port G. The division plate H serves as cylinder heads for both cylinders, through which the piston rod passes, the latter being rendered steam tight by a compact form of brass packing, which is said to wear well. The valve is balanced by the steam pressure within and without, when running, but when stopped the valve has a tendency to fall away from its seat, returning with a disagreeable click; this is overcome by the little plug piston J, operated by high pressure steam direct from boiler, which holds the valve to its seat with a gentle pressure, readily permitting it to relieve itself from a "slug" of water, caused by foaming or otherwise.



WOOLF COMPOUND CYLINDERS.

* * *

Among the "queries" discussed at the recent meetings of the American Society of Mechanical Engineers was one as to whether it pays to pickle ordinary castings, and it is noteworthy as indicating change in practice that the sand blast was held to be far superior to pickling. A question upon the smallest tool that it pays to drive independently by electric motor brought out the response that it does not generally pay to use a motor of less than five H.P. Another query was, "Have you any notions on machine shop floors?" to which it was replied that spruce floors 3 inches thick, overlaid with 1¼ inches of hard rock maple, are very durable.

THE CORLISS ENGINE.—2.

DESIGN OF THE REYNOLDS CORLISS VALVE GEAR.

A. H. ELDREDGE.

In the last article the width of the steam port and the travel of the valve had been determined, from which we can proceed to find the travel of the wrist-plate and the throw of the eccentric, as follows:

Start with the valve gear in its central position, then angle (a), Fig. IV., will average between 0 and 10 degrees, while the angle (b), which the two arms of the bell crank lever make with each other will approximate 105 degrees. From this the angle (c) can be easily found.

The lengths of the various lever arms will change with the different sizes of engines, but can be approximated from the table should come as near the center line (o o') as possible, due allowance being made that the valve-rod connecting heads clear each other in all positions of the wrist-plate. Some makers have gone so far as to attach both steam rods to one central pin, but this hardly seems warranted. From the above method the following deduction can be made: When the valve gear is in the central position—

First, let the angle (e d f) be as great as possible.

Second, make the connections of steam rods as near the vertical line passing through the center of the wrist-plate as possible.

These two deductions can be always followed, save where the ratio of the diameter of the cylinder to the stroke of the engine is very large, in which case the angle (b), Fig. IV., will approach 180 degrees and the connections to the wrist-plate will be

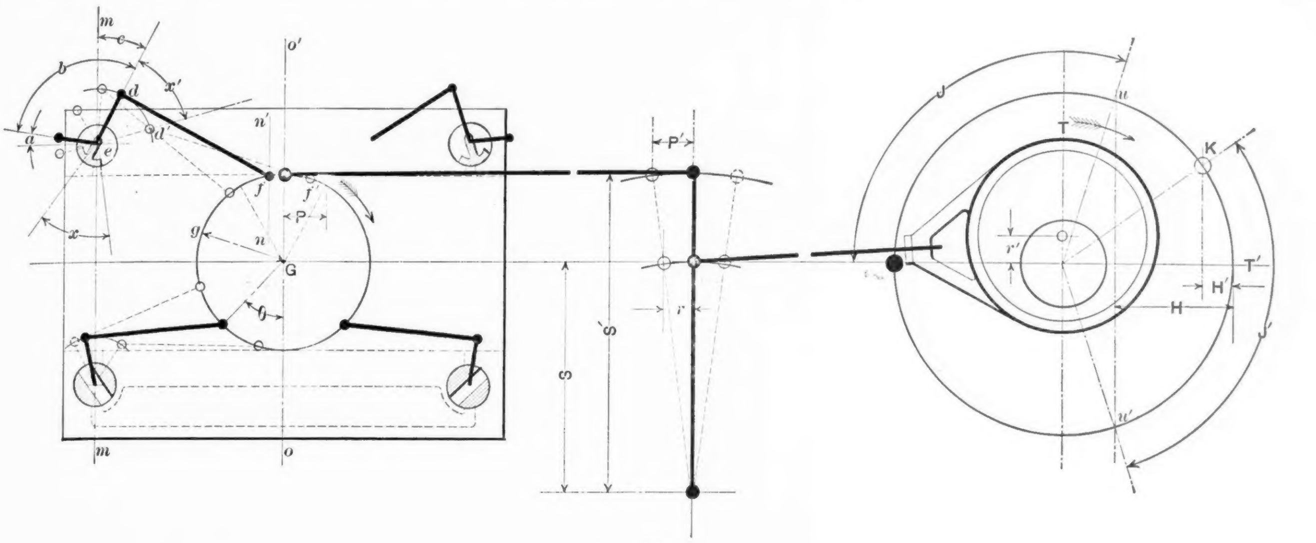


FIG. IV.

given in connection with Fig. VIII., which has been carefully taken from standard practice.

The next step in the progress of the work is to determine the diameter of the wrist-plate and the points of attachment for the steam and exhaust rods. Great care should be paid to this part of the work, or the objects sought for, i. e., a quick port opening and little movement of the valves while closed, will be defeated.

The writer knows of no fixed rule that can be applied to this work, but proceeds as follows:

From d, Fig. IV., draw a line at right angles to (e d); also draw a line (n n') parallel to (o o') and about 2½ inches from the same. Then the intersection (f) of (d, f) and (n n') will be the trial point of attachment of the steam rod to the wrist-plate, while (G, g) will be the working radius of the wrist-plate. The maximum radius of the wrist-plate will be enough greater than (G, g) to allow for the mechanical construction. The working diameter of the wrist-plate usually approximates the diameter of the cylinder.

The above method for determining the diameter of the wrist-plate and its connections should be used solely as the groundwork for the designer. The ratio of the diameter of the cylinder to the stroke of the engine varies greatly, and especially when compounding commences, so that the draftsman who adheres to any fixed proportions or rules would soon be at sea with his work. It might be that the above would give a wrist-plate too small or, indeed, too large; in either case, with the valve gear in its central position proceed where possible, by making angle (e, d, f), Fig. IV, greater than 90 degrees rather than less. Next find the position of the arm (e, d) when the valve is at its extreme travel and open—that is when it has moved through an angle (x) equal to angle (x'), as determined by the lap, plus the width of the steam port, plus the overtravel of the valve. With the valve in this position, note carefully the angle which the arm (e, d') and the rod (d, f') make with each other. The greater this angle the better, though care should be taken that any adjustment of the steam rod cannot bring the rod (d f) and the arm (e d) into a straight line, the result of which would at least be a broken valve bracket on the reversed motion of the wrist-plate. This angle should not exceed 160 degrees.

The point of attachment of the steam rod to the wrist-plate made as illustrated in Fig. VII., the dimensions of which are taken from the 40-inch by 48-inch cylinder of a triple expansion engine.

By making the connections to the wrist-plate as described, we secure the most rapid opening of the valve attainable with this mechanism. This can be proved by connecting the steam rod to any other point of the wrist-plate, as, for example, (g), Fig. IV. Then move the wrist-plate through a given angle and measure the amount the valve has traveled. Next connect at (f) and move the wrist-plate through the same angle and measure the valve travel. It will be easily found that the greater the angle

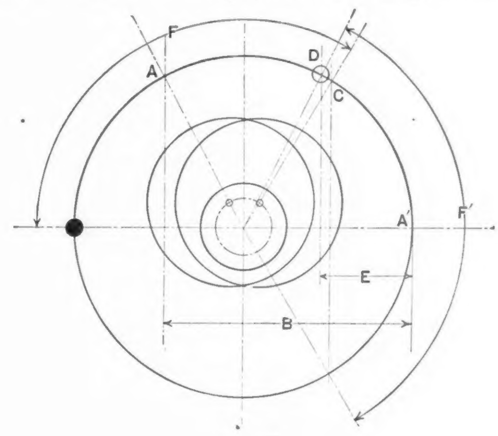


FIG. V.

(e d f) and the nearer the connection (f) comes to (o o') the greater will be the valve opening for a given wrist-plate motion. This the writer proved geometrically in an article published in the September number of "Power" of 1893.

The next point to be observed is the travel of the steam valve when the valve gear is in its central position and moving in the direction for closing the valve. In this case it is desirable to have the least movement of the valve obtainable, and especially it should be seen that the back edge of the valve does not open to the port and allow the live steam to escape through the exhaust of the cylinder.

Should it be found that the valve and valve gear have too much motion during this closing period, the wrist-plate connection and the angle (e d f), Fig. IV., can be modified to reduce this motion. Where there are two eccentrics and a negative steam lap, considerable travel is necessary during this portion of the cycle, while in the ordinary case the extra work thrown upon the valve gear, due to a little overtravel of the valve, is very small, especially when it is considered that the steam valve is seldom worked through its maximum range of motion.

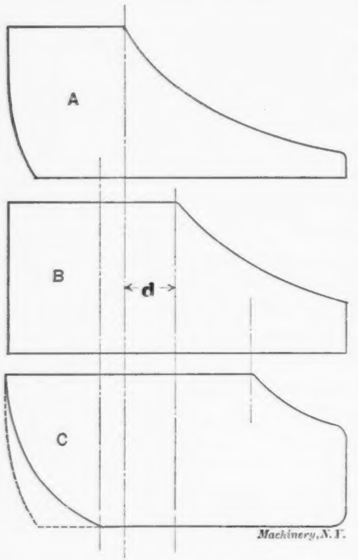


FIG. VI.

Once the steam valve connections are determined, those of the exhaust valves follow in easy order. The same objects are to be sought for as in the case of the steam valves, *i. e.*, a quick port opening and little movement of the valve when closed, and in addition the proper amount of compression. When the valve gear is in its central position the angle (Θ), Fig. 4, will vary from 35 to 45 degrees, and the exhaust arm will approach the vertical position. A few trials on the drawing board, moving the valve gear through its range of motion, will soon sttle these points.

Having found the travel of the valves as described, the vibration of the wrist-plate will simply be that which would produce the desired valve motion. In other words, the wrist-plate must travel in the direction of the arrow far enough to move point (d) to (d′), giving one-half the wrist-plate travel, the projected distance of which is equal to (P), Fig. IV. The distance (P) determines the one-half travel of the rocker arm, giving (P) equal to (P′). Next locate the center about which the rocker arm will swing, and we have (r) equals (r′) equals the throw of the eccentric.

The throw of the eccentric (r′) can be easily figured from this expression, as it can be taken directly from the drawing. Thus it can be seen that starting with the travel of the valve it is easy to work through the chain of motions to the throw of the eccentric.

TABLE OF DIMENSIONS.

Cylinder, inches.	A	B	C	D	E	F	G	H	J	K	L	M
12 x 30	6¼	13⅞	4	4½	4	11⅝	4	16 13/16	4	10	7⅜	3½
12 x 36	6¼	16	6	5 13/16	5	13 11/16	4	18	4	10	8¼	4 1/16
16 x 42	8	20⅞	5	4⅝	5	18	5	23 11/16	5	11	7½	4
24 x 48	12	23¾	8	5¾	5	19¾	6¾	26¾	6	16⅞	8¼	4⅛
26 x 48	12	25½	8	5¾	6¾	20½	6¾	28½	6	16⅞	8¼	4⅛
28 x 48	13¾	24 3/16	8	7	5¾	19 3/16	7	......	...	17¾	9¾	5½
36 x 42	14	26⅜	9	7	6	19[illegible]	7¼	27½	6½	22½	8½	4½

The advantage of separate steam and exhaust eccentrics has already been mentioned. This can be further illustrated from Figs. IV. and V. Assume, first, that neither the steam nor the exhaust valves have either lap or lead, as shown at the head end of the cylinder, Fig. IV. Then with the crank on dead center, the eccentric will be 90 degrees ahead of the crank. It is evident that as soon as the engine begins to turn over, the steam valve will commence to open and will continue to open until the eccentric moves through 90 degrees, passing from (T) to (T′). At this point the crank and piston will be at one-half (½) stroke, while the eccentric and wrist-plate will each have reached an extreme position and will now begin their return motion. The steam arm will at this point be raised to its highest position by means of the steam hook (see Fig. I., Art. 1). If now, the clip on the knock-off lever does not force out the steam hook and release the steam arm, then automatic cut-off will be impossible for that stroke, since the steam hook will then begin to move away from the knock-off clip. This gives, then, with admission and release when the crank is on dead center and with no compression, a possible range of cut-off equal to one-half the stroke of the engine and we would have a diagram, as shown at (B), Fig. VI.

Now then, suppose it is desirable to have a certain amount of lead, early release and some compression. This will require lap and lead to our valves, so that with the valve gear on center the eccentric would have to be turned ahead an amount equal to the lap plus the lead, as shown at (U), Fig. IV. In this case the eccentric will rotate through less than 90 degrees before reaching (T′) the end of its motion, while the crank will only have traveled through a distance equal to (H), thus cutting down the range of cut-off to less than one-half stroke, and compression will commenced at a distance equal to (H′) from the end of the stroke. Let the angle (J) be the amount the eccentric has been set ahead of the crank. Drop a perpendicular from (u) to (u′) and let angle (J′) equal angle (J); then (K) will be the position of the crank when the eccentric closes the exhaust valve; in other words, the position of the crank when compression commences. At (A), Fig. VI., is represented the diagram with this disposition of the valve gear. From diagram (A) it is easily seen that by increasing the compression we have reduced the range of cut-off by an amount equal to (d). Thus where but one eccentric is used, if we increase the compression we do it at the expense of a reduced range of cut-off, while if we increase the range of cut-off we do it at a diminished compression. Usually under these conditions the range of cut-off is about 30 per cent. of the stroke of the engine.

The advantage of two eccentrics can be seen by an inspection of Fig. V. With the valve gear in its central position there will be negative lap to the steam valve—that is, the valve will be open—then, with the crank on dead center, the eccentric must be turned back to some position as (A), Fig. V., for the proper amount of lead, in which case the eccentric will have to turn from (A) to (A′) before reaching its extreme position, or before raising the steam hook to its highest knock-off point, thus giving a range of cut-off equal to (B). The exhaust eccentric can be set ahead of the 90 degree position by any amount, as shown at (C), Fig. V. When as in Fig. IV., by making angle (F) equal to (F′) we would find compression to take place at (D), a distance (E) from the end of the stroke. So that it is possible to obtain any desired range of cut-off, or any amount of compression, where two eccentrics are used—a feature not be overlooked where such service as street railroad or rolling mill work is considered. At (C), Fig. VI., is illustrated a diagram such as can be obtained with this arrangement of eccentrics and valve

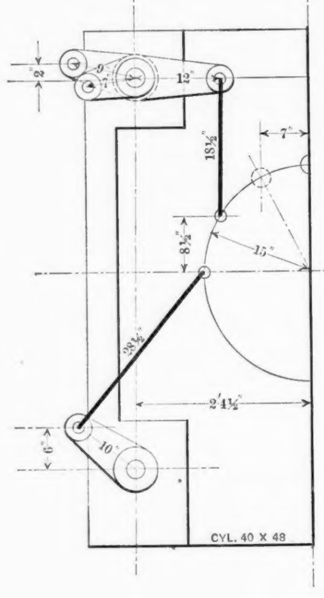


FIG. VII.

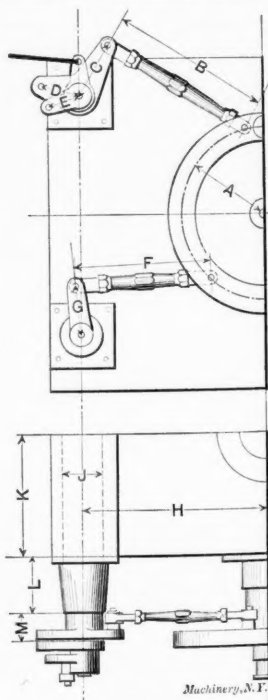


FIG. VIII.

gear, while at (A) the diagram shows the greatest practical cut-off where but one eccentric is used.

The above description has not taken into account the influence of the angularity of the connecting rod, especially since with the Corliss engine it is possible to get equal cut-off at each end of the cylinder for any position of the piston, by adjusting the governor reach rods. Neither has the possibility of a widely varying range of cut-off with one eccentric been considered,

which has been done in a few instances, as that of the large Allis engine at the World's Fair at Chicago, where a vibrating knock-off lever followed the steam-hook back and forth at each stroke of the engine.

The next article will treat somewhat of governors, safety-stops, valve-setting, etc.

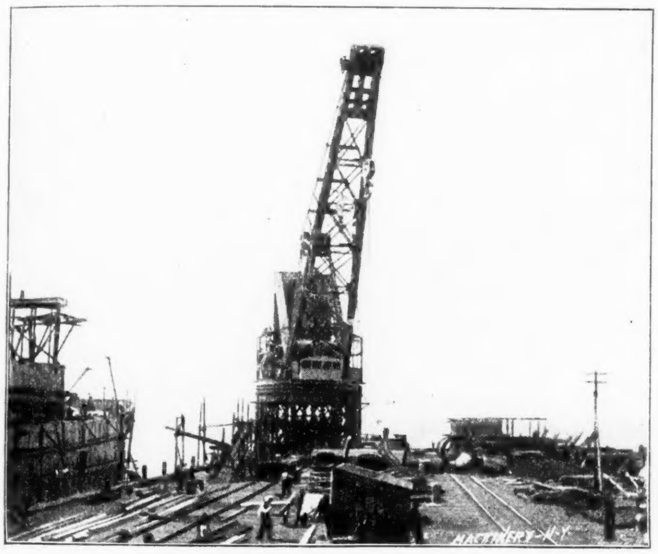
* * *

A POWERFUL LIFTING DERRICK.

D. A. Willey.

One of the most powerful mechanical structures ever erected for lifting heavy weights is the revolving derrick at the plant of the Newport News Shipbuilding and Dry Dock Co., at Newport News, Va. The battleships constructed at this point necessitate the transfer of some very heavy weights, and especially for this purpose was the derrick built.

The derrick is constructed of steel, is operated by electricity throughout, and has a maximum lifting capacity of 150 tons, dead weight. It is composed of a steel tower, or framework, carried on pile foundations. This tower, which is circular, is fitted with a track for the rollers which carry the movable or revolving portion of the derrick. The revolving portion consists of a heavily framed structure, circular in general form, and carrying in turn a movable jib, from the outer end of which the several hoisting blocks descend vertically. The revolving portion of the derrick carries all the motors and machinery required for the various movements as well as the balancing weights required to offset the tilting tendency of the jib. The



150 TONS CAPACITY.

revolution of the derrick is effected by means of two pinions, which engage with a circular rack fixed to the stationary tower or framework. Each of these pinions is driven by a General Electric motor, capable of developing 20 HP. The racking movement of the jib is effected through the means of wire ropes leading over sheaves at the top of the jib, and wound on large drums, which are located in the revolving structure of the derrick. The inner and lower end of the jib has a pin connection to the revolving structure, so that by winding up to the drum the outer end is raised and brought in towards the center, while unwinding the drums lowers the outer end and moves it out from the center. The hoisting blocks are carried as before mentioned, from the outer end of the jib, and the leads from these blocks run down the jib to drums, which, like the others, are operated by electric motors. There are three hoists from the jib, two main and one whip. The hoisting blocks in the low position of the jib are 69 feet above mean high water, and, on revolution of the derrick, describe the circumference of a circle 207 feet in diameter. With the jib in its highest position, the hoisting blocks are 118 feet above mean high water, and will describe the circumference of a concentric circle 88 feet in diameter, thus permitting the derrick to handle weights lying within the circular ring, whose maximum and minimum diameter are 207 and 88 feet, respectively. The maximum load of 150 tons can be handled only within a ring of whose maximum and minimum diameters are 147 feet and 88 feet, respectively, but weights up to 70 tons may be handled throughout the entire field of the derrick's operation. Tests of the derrick show that from 10 to 12 HP. are required for revolution. From 64 to 90 for the elevation of the jib, and from 29 to 54 HP. for the main hoists, with load varrying up to a maximum of 68 tons. For the whip 90 HP. is required for a load of 19 tons, the load being hoisted at the high speed of 52 feet per minute. The derrick was designed complete by the engineers of the Newport News Shipbuilding & Dry Dock Co., and was constructed and erected, with the exception of the steel tower, at the works of the same company. The steel tower was built and erected from the designs of the company, by the Berlin Iron Bridge Works, of East Berlin, Conn.

* * *

FOREMEN VS. NEW APPLIANCES.

W. D. Forbes.

After giving the public considerable rest, the writer again ventures into print on the subject of recent improvements in machine shop tools.

We all know that most makers of shop tools or appliances have some special feature which is considered the strong point of their production. It is talked by the salesmen and advertised; in all other points the tool is fully the equal of any other, but on this one point it stands alone. Most of these special advantages are supposed to enable a workman to give a larger output.

In the great majority of cases there is no doubt but that more work can be obtained by use of the improvement, but the question arises, Do the improvements actually reduce the cost of labor directly or indirectly? In the opinion of the writer they do not once in twenty times. Now, then, what is the reason of the failure? It is not in the device, but in the management of the shop. The foreman does not insist on the men using the improvement to its best advantage, if at all.

There is, for instance, a very nice drill holder for lathe use. A set was bought by a friend of the writer, and they are in his tool room, and there they have been for over two years, the men preferring to take a lathe dog and mar the shank of the drill with it rather than ask for the drill holders.

Again, some lathes are provided with an arrangement for cutting threads, which requires a small part of a minute to change from one lead to another. Its use would save time, but dropping out on even and multiple pitches instead of backing the lathe would save over and over again as much time, yet it is the rare exception to see a foreman insist on a machinist taking advantage of this dropping out, which is readily done on any lathe and on many jobs.

The graduations on the neck of the cross-feed screw, which are so convenient, are rarely used. Most men disregard them completely; yet they are time savers.

There seems to be an antipathy among machinists to tapping attachments, and just why, it is difficult to tell, unless it is the fear of breaking taps; yet their proper use saves money.

There are many very satisfactory time savers in the way of shop appliances which can be had for very little money, and the reason that they are not more generally bought seems to be that their value is questionable, simply because if bought they are apt to be unused from indifference. This indifference is more on the part of the older machinists, who have learned old methods and are loth to take up new ones.

In short, while the writer is more than ready to acknowledge the worth of recent improvements, he thinks that if a saving is desired in a machine shop, it can be best obtained by a foreman seeing that what is at hand is used in the best way rather than in supplying him with new appliances.

A foreman who does this will have no trouble in getting his employer to give him any new device which looks like a good thing.

* * *

Some statistics were given in a recent issue of the "Purdue Exponent," the college paper of Purdue University, Lafayette, Ind., regarding the 144 alumni of the electrical engineering department. Nine per cent. of the alumni are making over $1,800 a year; 17 per cent., over $1,500; 34 per cent., over $1,200; 48 per cent., over $900, and 80 per cent. are making over $600 annually. One hundred of the graduates are known to be engaged in various kinds of electrical work.

NOTES BY A ROVING CONTRIBUTOR.—10.

A NEST OF MILLIONAIRES—THE FACTOR IN CONTROL—A PROFITABLE WATER WORKS—COLUMBIA RIVER STEAMBOATS—MORE ABOUT STEAMBOATS—LOOSE ECCENTRICS—THE KLONDIKE FLEET—WHALEBACKS AND O'LEARY RAFTS—THE BRITISH EMPIRE.

I will not remain long in this country up here. The notes are all the time getting switched off into economics, which most people would say has nothing to do with machinery and mechanics, but it has, nevertheless. We build factories, make machines and operate them to create a difference in value between the material and the product, called a "profit," and profit is especially amenable to the laws and rules of economics.

In Portland, Ore., from where these notes are written, they tell me there were more millionaires to the acre than in any other city in the world. Not having any near relatives among this class of people and no hope of emulating them, I took the statement without verification. Millionaires mean an inequality of human conditions and this means paucity of the agencies that found and maintain skilled industry. This idea of "making" things is not congenial to the millionaire; it is too tedious and the margin too narrow, unless he has what they call out here a "cinch."

The factor, or agent, is in evidence here; he is also "boss." His liabilities are in Chicago or New York at four per cent., and his credit here at ten or twelve per cent. He is an importer and "making" things is not to his liking. New countries are not favorable to manufactures and are bad in various other ways. We should be thankful for that trait in human nature that leads men to self-denial for pioneer purposes. Their business is to produce hides, timber, potatoes, coal, wood and beef. Skilled industry belongs in old crystallized communities, and, in fact, is found there only. If one goes into a machine works here they will see here and there a modern implement sandwiched in between the obsolete and absurd, and by looking intently at the owner's face you can read what in words would sound as follows: "I must sell for cash in order to pay for iron, steel, coal, timber and wages, and cannot do it, hence my way is hard. The agent is, in fact, a 'branch' of some firm in the East and does not mind six months, or even twelve months credit. My only hope is in a break-down."

Eighteen years ago (I was here and saw it) some enterprising patriots had built a coffer dam out in the Willamette River in front of the town, put some pumps in the pen, raised and distributed water at a cost of 5 cents a thousand gallons, and sold it for a dollar. They had a "franchise," to which the water system was an attachment. It is gone now, happily, so also a good many other "cinches" which rendered local skilled industry a slow pursuit in this region.

One thing they can do up here—build river steamboats. Not counting the bay steamers on the Atlantic coast, which are not of the river class, the whole tribe is composed of ramshackle structures of an amphibious, short-lived nature. They are never far from the earth, either at the sides or at the bottom, and their career is one of bumps, jams and rubbing that precludes any idea of endurance, and consequently of investment, though here in the lower Columbia River they do better. The hulls are above ground far enough to permit them to be shaped for speed and also to allow the displaced water to get back and close in behind the boat to furnish a foothold for the wheel, consequently the wheels are made small in diameter, and seize on the water like a track locomotive climbing a hill.

They load on a thousand tons of freight and push the boat 17 miles an hour with one cord of wood fed at each end of a firebox boiler. I am speaking of a typical boat on which I made a short journey to "see how the thing worked," and if comparisons were not odious one might say that the Mississippi steamboats of our time are decidedly inferior. I am informed that this matter is balanced up by a fleet of nondescript craft about San Francisco Bay. We will see.

It is unfair, however, to speak disparagingly of the Mississippi steamboats. They are dead and are entitled to that reverence accorded to what has passed beyond its own defense. If conditions prove favorable, I propose to go around by the Gulf Coast and send in a whole chapter on Mississippi steamboats, maintaining that one time they were the most ingenious and advanced type in the world, taking into account the circumstances of their environment. Their decline began in 1850 and in fifteen years the corpse was ready, so to speak. The genus had shrunk to a stern wheeler pushing a fleet of barges, so also the people who knew these boats; they are growing scarce. They went out with the system.

There is a ferryboat somewhere about Olympia I happened on one night, that had loose eccentrics to operate the engine valves—the only case of the kind met with in this country. The eccentrics are loose on the shafts with a stop each way at the "angle of advance," so they operate the same for going ahead or astern. The idea is old. The Penns, of Greenwich, London, famous engineers, use this device on their small river boats that divide their time between "ahead" and "astern." It is a very simple reversing gearing, but is doubtless open to objections, otherwise would be more commonly used.

Just now the Coast fleet of steamers has been thinned out by the Klondike traffic. This Klondike business, which is a living fact around here, is one of those peculiar phenomena that comes around about once in twenty years, and appeals to a human trait that will not stand philosophising at all. It is an inborn penchant of getting something for nothing, picking up wealth from nature's storehouse direct, without the intervening hard knocks of the shop and farm. This counts for two-thirds of the Klondikers. The other third go there to prey upon the necessities and vices of the rest. An English writer has been footing up the commercial phase of the hegira of the past year, and finds it $50,000,000 "out" and $10,000,000 "in," but he has perhaps not allowed enough for the gold smuggled out to escape the Dominion taxes.

Taking into account the character of the craft that went up there it is a mercy that a third of them were not wrecked. A mild season saved them. The government takes a paternal interest in steam craft and surrounds them with a network of "Revised Statutes" that has come nearer destroying the whole business, but there seems to be no regulations to prevent a scampish shipping firm from sending out any kind of a rotten sailing vessel with a load of passengers to be drowned.

Continuing in marine matters, they build up here those nondescript craft called "whaleback" sea barges, that make the attempt of propelling themselves instead of being towed. Readers will remember how a few years ago we were informed that the science of marine architecture had gone to the dogs after thirty centuries or so of mistaken effort, and that the spoon stem barges were to revolutionize the whole matter. They have done one thing—cheapened and degraded shipping. The first one that came out here hammered her nose off on the seas, but others, I am told, are more successful. The whole scheme is a struggle for cheapness, and is twin brother to the O'Leary raft, of which a number have been constructed here, and one is now sloshing around the Coast in as many pieces as there were logs, to imperil steamers. Such inventions confer no general good. They are a sacrifice to cheapness with countervailing risks, and come under the head of what the Britons call "fads." There are good, stanch steam vessels to carry down all the timber wanted at a fair price, without sending it in rafts.

The British Empire, a section of which lies near at hand here, does business in a quiet way and at much saving in newspaper and other vaporing. A friend of mine in Victoria rowed over to Esquimault recently, two miles or so, to call on some friends at the village there, and was met at the landing place by a man with a gun, who said: "There is no village of Esquimault now. It was bought and is now a portion of the Dockyard." Just think of what was lost to the press and the barrel-head politician. I had intended to go up there before leaving this field for a look through the Albion Iron Works, but that is no doubt also in the Dockyard by this time.

* * *

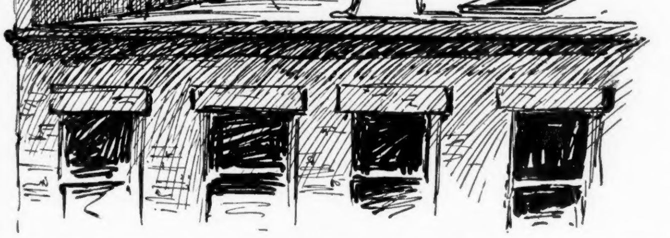
The only rotary engine that has ever met with any marked degree of success is the steam turbine, which strictly is not a rotary engine, and it is probable that this is the only kind that will figure very prominently in the future. A fair indication of the prospects in store for the turbine may be had from the fact that the Westinghouse Machine Co. are about to build three Parsons' steam turbines of 500 HP. each, for the Westinghouse Air Brake Co., to replace three ordinary steam engines. They are also building a 2,500-HP. turbine for the United Electric Light & Power Co., of New York City, the first of an order of five of the same size.

DOINGS OF THE SHELL-FISH CLUB.

It was high tide on the beach and the Freckled Faced Clam sat on the highest pinnacle scheming a way to further his hobbies in the world. Although in the zenith of his power and glory, he was dissatisfied. A graduate of Yale, Harvard and one or two other technical hatcheries, he was the greatest crank for "system" on the shore, and his chowder-mill was just reeking with it. No mechanic in the place could move without making some sort of a symbol somewhere. Every workman had a clerk to check and tally everything that was done; the cost and time departments were loaded down with clerks making all sorts of ex-equational accounts; a clerk always climbed the whistle pipe and made a record of the amount of steam required to stop and start the factory, and the millionaire oysters, who furnished the sinews of war to keep the pay-roll going, could always find any old kind of an account they wished about the factory except a dividend. But those things very seldom bother the Clam, as he had "system" on the brain and he spent his time getting more of it.

Suddenly a broad smile illumined his mouth and he jumped up and remarked aloud, "I have it." That day he had ridden over America's greatest railroad, and, sitting in the back seat of the chair car had watched the continuous working of the hundreds of semaphores. At every vise-worker's bench he would put up a semaphore, with arms, red, blue, white and black. Each vise hand would be furnished with some fine sharkskin bags, and as the parts he was working upon were finished, and ready to go to some other department, he would simply chuck them into the bag and hang them on a hook, which would pull up the proper colored arm on the semaphore, and his duty was ended, and the duty of the first one coming that way going towards the department indicated by the colored arm would be to grab the bag and deliver it at its destination. So it would work all through the factory, and it would be a great saving of labor and keep the clams busy who had errands calling them to different parts of the shop. Then he would have a "semaphore clerk" to keep tab on them and see how it worked. "Clerks are cheap, you know," he remarked, as he dropped off the rock and went to the mill to have the signals and bags made.

The apparatus was all gotten ready and would be in place in a few days, and in his dreams, while listening to the less educated shell fish at the club, he could see all those signal arms bobbing up and down as the work was hurried toward completion in the factory—and then happened a cataclysm. The Oysters wanted dividend soup instead of systematic suction, and the Freckled Faced Clam was "fired;" that is, he "resigned."



A CLERK CLIMBED THE WHISTLE PIPE AND MADE A RECORD OF THE AMOUNT OF STEAM REQUIRED TO STOP AND START THE FACTORY.

The bags and signals were put in the rubbish heap down cellar and the mechanical world lost another great and scientific paper on "the only perfect system of running factories." But the concern is making money without so much of it, and the hundred and one clams before used as clerks are in more beneficial vocations for their fellow creatures, making chowders and broths. You ask what became of the Freckled Faced Clam? Oh, he wrote "System Fairy Tales" for the Oyster Bay "Blower" for a season, and now lives in a cyclone cellar out in Kan-

THE DUTY OF THE FIRST ONE COMING THAT WAY WOULD BE TO GRAB THE BAG AND DELIVER IT AT ITS DESTINATION.

sas, and deals in real estate while systematizing the 16 to 1 problem.

* * *

THE FIRST STEAM WAR SHIP.

The following interesting account of the first steam war vessel of the navy is taken from an article published in the New York "Sun":

During the war of 1812 the United States Navy was making an excellent record at sea, but the government felt the pressing necessity of vessels for coast defence. Finally a suggestion by Robert Fulton was adopted, and by special legislation Congress passed an act in the same year authorizing the immediate construction of a number of floating batteries after a type submitted to the Navy Department by Fulton.

On June 20, 1814, the keel of the first of these new war vessels was laid at Corlears Hook, on the East River, and Oct. 29 of the same year the "Demologos" was launched. She was 156 feet long, 56 feet beam and 20 feet deep. As viewed in the light of modern times, the most peculiar thing about the ship was the situation of the propelling power. In the center of the deck there was a well-like opening, straight down to the water, in which the single paddle-wheel worked. At the last moment this well was converted into a channel 70 feet long and the paddle-wheel was increased to 16 feet in diameter. The vessel was propelled by a single cylinder. The equilibrium of the vessel was preserved by having the cylinder on one side of the wheel and the boiler on the other, all the machinery being placed amidship.

To make rapid maneuvering in any direction possible the "Demologos" was provided with two bowsprits and jibs and four rudders, two at each end, by which arrangement she could be propelled backward or forward, like a ferryboat.

The day of the launching marked the beginning of a new era in the navy and was a memorable occasion. When the "Demologos" entered the water she left behind her old name and was christened "Fulton the First," despite the protests of her modest namesake.

The "Fulton the First" never had an opportunity to demonstrate her worth as a fighting ship, although she would doubtless have proved a formidable opponent to any war vessel on the sea At the close of the war with England the "Fulton" was tied up opposite the Brooklyn Navy Yard, and remained there until June 4, 1829. On that date two barrels of powder stored in her hold exploded, and the ship was blown to pieces. Between twenty and thirty men who were on board at the time were killed. The cause of the explosion was never found out. Some years later another vessel in the navy received the name of "Fulton."

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JANUARY, 1899.

We are approaching the limit of space that we are willing to devote to advertising in MACHINERY without increasing the reading matter, which we cannot do at the present price, because twelve issues of the paper cost us now $1.09 to produce and mail, and in order to restrict the advertising space we have increased the rates on an average about 12 per cent., beginning with this issue. Apart from the reasons above given, this increase is justified by the circulation, now more than double what it was when the present rates were established, and showing a constant growth each month —the increase for January alone being over three thousand five hundred copies.

The first three years of MACHINERY's life were years of hard, up-hill work; but now, thanks to our many friends among both readers and manufacturers, we are glad to say that business comes easily—all we want and more, as is shown by the sale of the front cover to different concerns, entirely without solicitation, until February, 1900. L.

* * *

On the night of Dec. 4 the upper stories of the magnificent Home Life Building, 256 Broadway, which is almost within hand-shaking distance of the offices of MACHINERY, were completely gutted by fire. This was the first fire test that any of the modern "sky-scrapers," which are so numerous and prominent in lower New York, have been subjected to. These buildings are supposed to be so constructed that fire starting on the inside can be confined to within at least a floor or two of the place where it starts. In this case, however, flames from an adjoining building shot up along an outside wall and entered the different floors through the various windows, making it impossible to check the progress of destruction.

The offices of our contemporary, "Locomotive Engineering," were on the fifteenth floor of the Home Life Building, and they were destroyed with all their effects, including the latest mailing list of subscribers. The management therefore request all their subscribers to send them their names and addresses with dates of expiration. The paper is now located in new offices at 95 Liberty street. Part of the same floor of the Home Life Building was also occupied by the "American Machinist" up to within a few days of the fire, when they moved to new quarters at 218 William street. We heartily congratulate them on their good fortune.

* * *

MANUAL TRAINING SCHOOLS.

The time was when the boards of education in our large cities considered training boys in public schools for industrial pursuits a fad, and were slow in making appropriations for manual training. Many contended that it would be detrimental to a boy's education—that he would be less inclined to apply himself to his studies—in fact, it was said it would "break a boy all up" for study in the class room.

The opposite opinion now obtains, for instead of two hours a day in the shop interfering with a boy's studies, it has proved a help rather than a hindrance, and to-day in the cities of New York, Chicago and elsewhere manual training is not only thought to be in its right place, associated as it is with high school studies, but it has found its way into the grammar schools also. Of course, in the latter it is of a very elementary character (working wood only), but the boy is better prepared for the high or manual training school when he enters it.

Boards of education have been generous of late years in their appropriations to manual training, especially in the city of Chicago.

Notwithstanding there is much good being done in this way for the youth of America, there is room for improvement in teaching the mechanical arts. It is not sufficient that the teacher be a good workman himself, knowing all the best and latest shop practice, but that he should know the best method to impart the knowledge he possesses. This is very important. It is hard to say which of the two evils is the greatest—the teacher who cannot teach, because he cannot himself work, or the teacher who can work, but who cannot teach.

The best exercises are not always those that look best when finished, and much of the object of manual training in schools is lost owing to the desire to make a showy exhibit of work at the end of the year. For instance, a boy makes something that is admired for its appearance, yet the making of it might not have given the instruction and training necessary to the development of skill that something less attractive would have given.

A favorite wood turning exercise is to select several different kinds of wood, and after glueing them together turn some fancy article and daub it over with varnish to make it shine. To the uninitiated this may appear to show excellent workmanship, while possessing little value from an educational standpoint.

In bench work a plain piece of cabinet work gives a boy some idea of construction, but in this kind of work, also, many instructors, for the sake of effect more than instruction, aim to produce something very ornamental and go as far as to add brass trimmings and other frills.

In the foundry there is the same danger of allowing the boys to amuse themselves molding and casting ornamental work, which does not give them much idea of foundry practice. A common exercise in the blacksmithing shop is a lamp stand, mostly made up of scroll work bent from light iron by round-nose pliers or tongs. Such a piece of work has its value, but does not teach the art of blacksmithing.

Work done in the machine shop is not so much in the form of amusement, owing to the conditions, for when a boy works a drill press, slide rest lathe, planer, shaper or any other machine, he is getting the same kind of practice that he would in a manufacturing concern, and if the piece of work he is doing is not clamped or set in the machine as it should be, the machine will soon inform him of the fact. In the machine shop, having to do with automatic attachments on machines, and to work to fine measurements, boys learn to be careful, which is the first essential to becoming a good mechanic.

The exercises that will develop a mechanical skill, and which also have some market value, are those least desired by the boy, as such are the least interesting.

To design or choose exercises that shall be both interesting and instructive is the teacher's problem. The making of orna-

mental things has its value, in that it is a relief from the regular exercise work, for the ordinary boy will work with more interest on some pretty object that he is to take home, anticipating, as he works, the praises of Ma and Pa. But he should be given to understand that it is much more important to be able to plane a piece of wood straight and square, to make a good half lap joint, to turn beads and hollows regularly and in the right manner, than to make a fancy box or stool and cover up the bad joints with shellac, glue or silver mountings.

In view of the fact that a large number of manual training school boys after graduating find their way into manufacturing plants, especially those building machinery, it seems that pattern making, the most important branch in the wood working department, is often put in the background. Pattern making should be put more to the front, so that a boy can see the use, and find out the quality of his work in the foundry. To teach a boy to make, say, a pattern and corebox of a small gate or globe valve, or any simple piece of machinery having some core work about it, is training him to do that which will be closely related to his future practice. Such work, however, would in all probability be scarcely noticed on the regular exhibition day of students' work. Again, foundry work and pattern making, being sister arts, should be more closely connected and instruction given in both branches the same year. Pattern making is not considered a wood working trade in the same light that carpentry, cabinet making, wood carving and others are, for the reason that patterns to mold and make castings from are regarded more as tools, used to make something with, rather than things to look at and admire for their beauty. For this reason pattern making might be separated from the first year's wood work, and made a companion to foundry practice in the second year. P. S. Dingey.

* * *

Boiler explosions are generally ascribed to every imaginable cause, except the right one, which would in most cases show neglect or bad practice by some one. The latest explanation of this character that has come to our attention is contained in an article in "The National Engineer" upon an explosion caused by "superheated water," and this is the way the mystery is explained: "When the air is boiled out of water it becomes more dense and can then be superheated, refusing to boil even when at a temperature many degrees above the boiling point of fresh water. Something of this kind occurred in this boiler. The air having all been boiled out, the water absorbed an excess of heat, and when the pressure was relieved by the starting of the engine, the water was set in motion and steam formed so rapidly as to produce an excessive strain—and the boiler gave way." Another part of the article incidentally mentions that the boiler was patched, and that the rupture began "in the middle of the sheet, just below the patch." The only needed comments are a few exclamation points.

* * *

A GEAR TRIMMER.

A. H. Cleaves.

Having occasion some time since to retouch a thousand small brass gears that had been mounted on arbors or staffs about 1 inch long, I used a device similar to the one illustrated, using the gear itself, however, for an index instead of a separate piece.

In the busheling job that I speak of, the gear of fourteen teeth ran in a pinion of seven—a rather unfavorable number—and had been laid out to work well on condition of perfection in all, the details, center distances, etc., which were open to variation, the pinions running on a short shoulder screw, held in a typemetal piece, the drill for thread coming out on a joint or shoulder. This, of course, made the tapping vary a little.

I put a straight face on the leaves of the gear, and the pinions after this could not be made to lock. The wheel and pinion had little or no work to do, being used in a counting or registering combination.

The facility with which the gears were retouched led me to believe that a tool like the one I have designed would be very useful in cutting similarly divided pieces in the first place in many instances.

In cutting brass gears I have found it a good practice to center brass rods in the back-rest where the full size of the metal is to be used; or to turn the rods for them on centers when under size of rod. To utilize all of the rod both in the lathe and milling machine, use a sharp cornered square center to drive the work with, pressed well into center of rod.

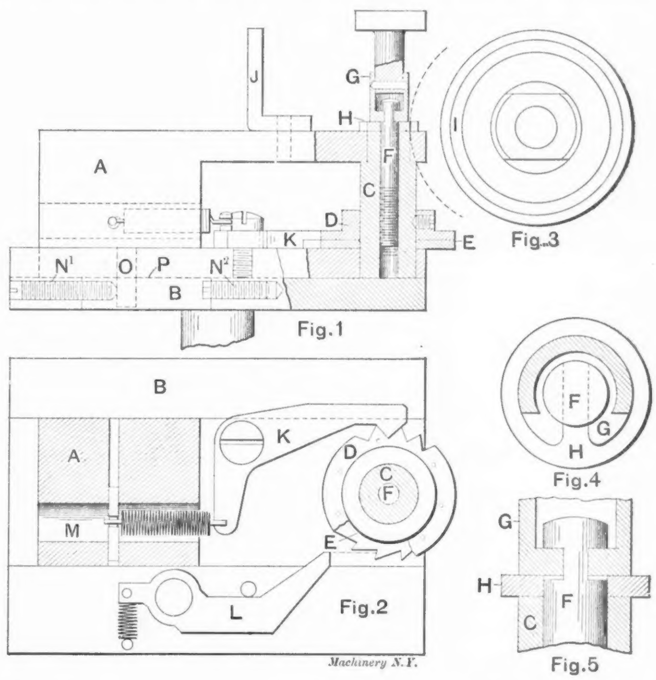
For holding brass wheels or pinions on to arbors or rods of any kind I have yet to find anything better than knurling the rod with a knurl straight lined on the edge. This will hold when the pound on the gear will cut a dowel pin off.

In the work which I went over, the milling machine being in use, I improvised the method spoken of before with complete satisfaction.

Referring to the drawings, A, Fig. 1, is a cast iron frame sliding in the piece B, used in the T-rest post of a lathe. This piece carries a hollow shaft C, containing the arbor F for the gear blanks H.

This shaft C carries a double ratchet wheel D and E. The upper wheel, D, has cuts for the retaining pawl K, and the lower ratchet wheel E, riveted to D, has straight-faced teeth adapted to the feed pawl L.

The pin O in the frame A stops the latter going and coming,



having a set screw N^1 for gauging the distance of L, and N^2 for getting the depth of the gear teeth. The pin O, however, should be against N^2, as the drawing is made. This pin O moves in a slot in B, shown by the vertical dotted lines.

In Fig. 2 at M a drilled hole for the spring and pin for the pawl K is shown. The pawl L gives the impulse to E, when the slide A is drawn back; it then lifts over the tooth and stops against a pin. The piece J, riveted to A, is a handle for sliding the latter forward and back.

The cutter I should have fine teeth preferably, and be of about two or more inches in diameter to cut acceptable teeth on the thicker wheels, etc.

The tightening nut G is one of my own importations and catches hold fast and sure.

G slips into the slots in the side of F, which is both arbor and binding screw. When E is brought back against L, F can be tightened readily and loosened, while K is held in D by the hand.

On larger work this kind of a nut can be made more effective by having a snap lever handle that will drop down at right angles to F, for tightening with the same, and snap up to a vertical position to be out of the way of the running cutter I.

This nut is quickly put in and out of place and acts instantly.

After running once around slowly in cutting the teeth, the burr, if any is there, can be removed by pumping the wheel around rapidly.

Chicago, Ill.

* * *

It is with pleasure that we note that the new traveling fellowship for architectural students at Cornell University has been awarded to a nephew of Sanford Dole, the late president of the Hawaiian Islands. Young Mr. Dole spent the first fifteen years of his life in Honolulu.

AMONG THE SHOPS.

FROM WEST TO EAST—AN ENTERPRISING SHOP "DOWN IN MAINE"—A SUCCESSFUL SYSTEM OF MANAGEMENT.

Before continuing the series of articles on observations in Western shops, I should like to call attention to some of the things to be seen nearer home, and in the present instance shall endeavor to give some idea of the methods employed by the enterprising firm of Fay & Scott at Dexter, Me., whose shop is the only one in the State where much, if, indeed, any, machine tool building is being done at the present time. Dexter, one of the brightest of the small Maine towns, has 3,000 inhabitants, and, owing to its position on the Maine Central Railroad, which, through connection with the Bangor & Aroostook, Canadian Pacific and Boston & Maine roads, affords convenient railroad shipment in all directions, has a promising future from a business standpoint.

FIG. 1. THE WORKS OF FAY & SCOTT.

In 1881 Walter Scott and Norman H. Fay, shopmates, rented a part of the shop where they were employed as working mechanics, and, under the firm name of Fay & Scott, started in business as general machinists and tool builders. Although at this time Bangor, the head of navigation on the Penobscot River, and 30 miles distant, was the nearest point for shipment by water, and raw material and markets for product were both remote, success attended the new firm from the start, and they were scarcely settled in the first building erected for them in 1890 before it was found necessary to enlarge the premises.

The next few years necessitated several additions to the original building, but so admirably has the whole been planned, that there is scarcely a visible sign of this piecemeal construction.

Fig. 1 is a general view of the works as they appear at the present time. On the right is the brass and iron foundry, 40 x 80 feet. A small portion of a slate-covered wooden structure, 40 x 50, is visible between the foundry and the main building; that is where the rougher work is done on the castings, and with this one exception the buildings are all of brick. The largest building in the plant is 200 feet long by about 50 feet wide, and the upper story is devoted to the pattern work. The latest addition is a 17 x 20-foot extension for office purposes on the rear of the building, directly opposite the tower, where it is flooded with light all day and is very attractive. Fig. 2 shows a portion of the interior of the office seen through the glass partition which divides it from the drawing room. This particular view was chosen so as to include the transparencies in the glass partition, although the amount of light within prevented a good photograph being secured. These transparencies represent specimens of machinery built in the shop, and the happy effect produced by them caused me to wonder why they have not become a popular substitute for stained glass in similar cases.

When Mr. Scott retired from the business in 1896 Mr. Fay purchased his interests, retaining the firm name of Fay & Scott, and is now sole owner and general manager. His daughter, Miss Marion Fay, through her training and experience as bookkeeper in the office, was thoroughly fitted for the clerical work, which she has since handled with such proficiency, and Mr. W. L. Fay takes an active part in the business as his father's assistant.

The principal business of Fay & Scott is machine tool building, lathes in particular, but Mr. Fay is a hustling mechanic who does not hesitate to contract for almost anything short of a cambric needle or a clap of thunder. and in consequence most of the mechanics are all around workmen. It is doubtful if there is a concern in the State doing general machine work which has a shop that is better or more up-to-date in its equipment.

There is much that could be said both for and against the growing tendency to break men in and keep them on one thing, but this is a shop where the apprentice system has not given way to that plan, and a statement of which any machinery builder might be proud is that made by Mr. Fay when he said: "Outside of the men employed here at the present time, all save two of those who served their apprenticeship in our works are either in business for themselves or hold positions where they have at least one man working under them." Undoubtedly the secret of this lies largely in their training, for in addition to their regular work on machine tools, where first-class workmanship is indispensable, Fay & Scott do a considerable amount of general repairing and outside work of every description, which accustoms the men to working without the constant supervision of a foreman, and teaches them when a job is done and done well enough for the purpose. Under these circumstances it is quite natural for them to become self reliant and apt at divising ways and means to an end without regard to fixed conditions.

FIG. 2. THE OFFICE.

In addition to the foregoing I believe that I can honestly say

that there is not an intemperate man in the crew. More than that, his place would be filled if there was.

I have seldom found so many mechanics working with such apparent freedom from arbitrary restraint or displaying a greater personal interst in their work. Let us hope that one is the natural consequence of the other. After comparing these matters and many minor points that space does not permit me to enumerate with the workmen and conditions which have come under my notice in other States, I am inclined to believe that Fay & Scott's isolated situation may be somewhat of a blessing in disguise.

In some shops I have visited I have heard those in charge say they would willingly pay an advance of 25 cents per day for New England workmen at any time, and in many places I have been told that it is so nearly impossible to find enough sober, industrious mechanics that it was necessary to put up with what they could get. "They seem to think only of pay day and quitting time," is another very common complaint among those who employ skilled help, all of which makes it but natural that I should be impressed by Fay & Scott's apparent good fortune in such matters.

The utility of their latest design in turret lathes is quite promising, and the 13 and 32-inch engine lathes that were in the assembling department at the time of my visit had the appearance of being designed to meet their builders' own needs for stiff, serviceable tools. I was also much pleased with the appearance of their line of patternmakers' lathes, and those I saw ranged from a 66-inch gap lathe down to a 10-inch size, adapted for the use of the manual training department of schools and colleges.

One significant fact bearing on the relations of employer and employee is that every employee is paid in full every Saturday night, and the common excuse among employers that a week's wages, more or less, must necessarily be held back to give time to make up the pay roll makes Mr. Fay's system of time keeping the more interesting. His own description of it follows:

This system, of course, has come about gradually during our seventeen years' experience here, although we have had no occasion to change it during the past twelve years, and while it is adapted to all classes of shops, it is particularly adapted to those who, like ourselves, have to do all kinds of machine work, some of which is charged direct to our customers, while in other cases it is kept simply for record, cost, etc. The system is as follows: Over our shop desk we have as many clips as we have workmen, all on one board, with a workman's name over each clip. In the morning one of the enclosed sample time tickets is filled out for each workman, with date, workman's name, and in the space marked Job No.— is placed the name of the parties whose work he is doing, if it is work which is to be charged to a customer by the hour; otherwise, if he is on a special machine the name of that machine is put in "hours" place. If on some of our regular line of tools a letter is put which represents the symbol of that particular size of lathe, and this symbol is used on all the patterns and records of these lathes, then in one of the blanks below we put the name or number of the piece he is at work on; also the class of work, as lathe work, planer work, etc. When the workman gets through with this job, whether it be at the close of working hours, or early in the day, he puts the hours he has worked in the space for same, and when given a new job a new ticket is put with the other.

FAY & SCOTT.

Dexter. *Oct. 31,* 1898

J. Smith's time on

Job No. *John Jones*

	HOURS.	LBS. STOCK.
Rep. Engine	*3*	
Babbitt #1		*8*

TIME TICKET.

Possibly I can illustrate this a little better by submitting two tickets as they appear when removed to file away. One of these tickets would show that on Oct. 31 J. Smith made repairs on J. Jones' engine, three hours, and used 8 pounds No. 1 babbitt. The second one would show that on the same date J. Smith worked seven hours turning six No. 18 (i. e., main gears), on job D. D. (i. e., 28-inch engine lathe). When these tickets are put up in the morning each man's time is checked in the proper space on time sheet from week ending——, of which sample is enclosed, and the tickets are placed in a small box in the shop desk. This weekly time sheet serves to make up the pay roll each Saturday. At any time, either from day to day, or at the end of the week, whenever most convenient, these time tickets go to the office, where they are sorted by whatever is written opposite "Job No." All those marked D. D. being placed in a pigeon-hole until the

FAY & SCOTT.

Dexter, *Oct. 31* 1898

J. Smith's time on

Job No. *D. D.*

Turn	HOURS	LBS STOCK.
6 #18	*7*	

TIME TICKET.

job is completed, all those marked J. Jones going by themselves until the end of the week, or the completion of the job, when it is charged on our books. As to the final disposition of the tickets, each week's tickets that have been charged or entered on cost account are placed in one package, with an elastic band around them and dated on the back "Saturday———," and these packages in turn are filed in regular order. In making charges on our books or entering items in cost account, the date on which the entry is made shows that the time tickets to verify the same will be found in the package dated the following Saturday.

FAY & SCOTT.

TIME FOR WEEK ENDING SATURDAY 189

NAMES.	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Extra Time.	Total.
....	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......
....	......	......	......	......	......	......	......	......	......

This makes it very easy to go back to the original entries for time, workman's name, etc. In case of a question as to whether a certain piece of work had more or less time than previous pieces, a reference from our cost account back to the original tickets will show who did the work, and consequently give a very good record of each workman's ability.

In our particular case one great advantage of this system is that in case of absence, sickness or rush of business these tickets need not be sorted and entered under their proper heading until such time as they can be attended to; but the most patent advantage is that in case of a long job, such as a dozen or more lathes in a lot going through the shop, the tickets are simply filed in the pigeon-holes until the job is completed, no entries to be made until the cost on the lot is ready to enter all complete. Again referring to the ticket shown, D. D. No. 18: These D. D. tickets would all be together, but on entering on records can be subdivided into No. 18, etc., giving the date and cost on each particular piece of the job.

* * *

It is a matter of common experience that machine design depends more upon an acquaintance with mechanism and shop practice than upon a knowledge of the strength of materials. While the question of strength is always present, stiffness rather than strength is the governing factor, and if a machine be stiff enough to stand rigidly under the stress and jar that come upon it, there will be small doubt that there will be strength enough for all requirements. The safe rule to follow in designing a machine for stiffness and rigidity is to "put in the metal and plenty of it," until the proportions look right to the experienced designer. This is the method, however unscientific it may be, that is used in designing most of the machinery that is being built to-day, and there will probably never be another rule that on the whole will be so satisfactory.

MOLDS.—1.

PRACTICAL POINTS OF INTEREST ABOUT MOLDING IN ITS BROADEST SENSE, WHICH INCLUDES NOT ONLY CASTING, BUT DROP FORGING, COINING, COMPRESSING, EMBOSSING, ETC.

WARREN E. WILLIS.

The subject of molds may include in its comprehensive scope any arrangement of controlling, guiding and shaping parts adapted to receive plastic matter and impart to it desired form and size. The process of molding articles is, perhaps, as old as humanity itself; so old, in fact, that its origin is lost in the obscuring haze of antiquity, and the perfecting of these processes marks the advancement of civilization.

The fact that our forefathers never enjoyed, even as luxuries, thousands of articles that are now regarded as necessities only points to the fact of a higher civilization. How much of this can be attributed to a partial perfection of these processes is a question difficult to answer; but it is evident that in every department contributing to the comforts of modern life, we are dependent on the art of molding—that is to say, most of our hardware, domestic goods, personal ornaments, instruments and machine parts are the cheap and uniform products of some branch of this art.

Casting and Forging.

By a fortunate provision of nature metals are composed of infinitesimal particles—called molecules—which move among themselves to take new form, when constrained to do so by the application of the proper forces in connection with suitable guiding walls; in the case of casting, these metals are brought to a state of fluidity by submitting them to a high temperature, while in forging the temperature is lower or in many cases no artificial heat is needed.

Herein is the principal difference between casting and forging, and another point of dissimilarity is the fact that castings are usually made in perishable molds, while forgings are made in those of a permanent character; again, in casting, the force applied is seldom other than that of gravity, while in mold or die forging operations pressure is applied, often of hundreds of tons. It is with the latter that this article treats, except where later on it will be shown the one overlaps into the other.

Die Forging.

Molds may be roughly divided into three classes: First, those used for shaping metals, such as iron, steel and copper in a semiplastic condition, and which are more commonly known as forming or forging dies. This class requires both heat and force for the operation.

Second, those for metals, alloys, minerals and other substances in a fluid state, such as tin and its combination under the generic name of white metal, glass and the like in which heat and frequently moderate pressure is used.

Third, those for plastic substances that require the application of heat—or cold—as the case may be, in which time is a factor to enable the substance to arrive at a proper consistency, such as rubber, wax, soap and so forth.

It is somewhat doubtful where the line should be drawn in the first mentioned as between molds and dies; in fact, they are so closely related that there is little distinction.

The practice of making articles by drop-forging is one that appeals so irresistibly to the mechanic that it is increasing as rapidly as its adaptability becomes evident; greater density and homogeneity—therefore, strength—is obtained in the metal, freedom from sand, scale and blow holes, uniform size, weight, shape and rapdity of production, are strong points for consideration as between founding and forging.

Should the shape admit of practical forging and the number of pieces required be such that the cost of the necessary dies exceeds a reasonable proportional expense, it may be well to consider the probability of future requirements of the same pieces, or in lieu of that, of such future use of the dies in shapes that require but little changing, before making a negative decision.

If the pieces are to be of steel, tempered after finishing, another argument may be raised in favor of drop forgings over castings; however, quantity is usually and properly the governing consideration. In a general way, it may be said that the cost of making a few pieces bears no relation to that of making many and nowhere is it truer, perhaps, than in those pieces made in permanent molds.

In passing, it may not be out of place to mention that it is the practice of the leading concerns whose principal business is to make drop-forgings to charge a certain piece price for the first lot or first thousand, and a less price for succeeding lots, in order to cover the cost of the dies and experimentation involved, although from their general experience they can determine very closely the cost of dies, stock and labor included. It is also probably cheaper and more satisfactory for them to do such work for the average manufacturing company, unless the latter have sufficient work of this character to warrant them in the equipment of a special department for the business.

Flexible vs. Rigid Foundations.

It is, no doubt, thoroughly understood by the persons likely to have the matter in charge that the foundations for drop-presses should be of the most substantial character, reaching well down into the solid earth, or, better still, to the solid rock, yet there is an ancient superstition to the effect that it is the proper way in setting a press to interpose a flexible mat of rubber or an equivalent substance between the foundation and press base, to prevent vibration and lessen danger to dies. The fallacy of this is apparent without much mental effort, as it is evident that the yielding of the base counteracts and renders useless the rigid foundations. Presses so set require a sharper blow than those less yielding. The term "sharp" in drop-forging refers to the quality of the blow and is descriptive of a lighter hammer falling a greater distance to do the same work than a heavier one moving through less space.

The effect of the two blows is quite different on the work, an analogy being had in the simple operation of riveting, where a light hammer rapidly applied may form up a head and not materially upset the body of the rivet, while a heavy hammer is more likely to cause the body to flow as far as the hole permits. Sharp blows are harder on dies than those whose nature is more of a "squeezing" effect, therefore the danger to dies is actually less when held in a rigidly supported base.

A difference may also be noted in the action of the hammer, which requires a full pull the entire distance up in any case, after the first blow, and soon acquires a lively rebound as the work cools and assumes shape, if no springiness exists below it. As it would be considered something worse than useless to place springs under a blacksmith's anvil, so it should be regarded equally futile and senseless to do practically the same thing under a drop-press.

Points About Drop Forgings.

In the selection of a press it may be remembered that the function of the sides is simply one of guidance and the proper place for weight is in that portion representing the anvil, the "tup" or hammer being proportionate to the work to be done.

As every maker of presses builds on a somewhat different model, there is a range of styles to suit all, and as each builder will assure a prospective customer that his is the best machine possible for the work, at the lowest possible price, no trouble ought to be had in making a selection.

In whatever style, and however driven, whether by rope, hand operated, a strap wound around a pulley, a board pinched between rollers, or by steam direct, the action is practically the same. In each case, an upper die drops a given distance, delivering the accumulated force of its blow on an inert mass of metal lying upon the face of a lower die. A type especially adapted for machine forgings in shown in Fig. 1. The sketch is not intended to show up any particular machine, but represents a standard design.

In the case of iron and steel, the metal is heated to a color approaching whiteness, several blows may be successively struck and reheating may become necessary, while soft metals require no heat.

Where heat is used, as in the majority of cases, the shortest possible time that the work remains in the dies the better, as there is less chance of drawing the temper of the dies, and there is less heat absorbed from the work. For these reasons the hammer should be raised the instant the impact of the blow has been received.

Theoretically, the exact quantity of metal can be so placed

in the die that when the operation is completed the metal will just exactly fill the cavity; but in practice it is found more economical to allow a little overplus, that the entire space may be filled to a certainty. Some of this metal almost invariably protrudes at the junction of the dies in the well-known "fin," which must be removed and is provided for in the trimming press.

This latter may be an ordinary power-punch press, with the dies made to shear the "fin" from the work. The punch conforms more or less closely to the upper half of the forged work to prevent distortion and the operation is done cold, as in ordinary punching.

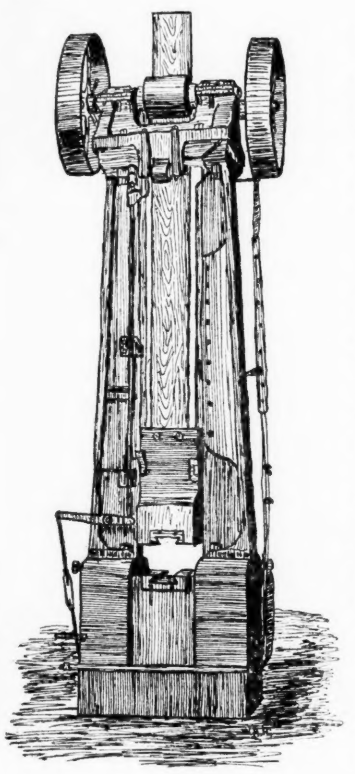


FIG. 1. DROP PRESS.

The experience of steel workers, whose judgment and veracity is good, is that when steel is quenched after slowly cooling from a heat sufficiently high to form a slight scale, it is in the best possible condition to be worked by cutting tools.

The proper point at which to quench the steel appears to be just as the last red glow fades from view when the article is held in a dark place—not quite hot enough to cause fine sawdust to ignite, but enough to make it slowly glower until consumed. At this degree of heat the nature of the steel is undergoing chemical changes, in which the carbon is of a graphite form, and any attempt to work it under the hammer at this critical stage is an outrage to which the steel retaliates by checking, cracking or direct breaking. Advantage may be taken of this peculiarity in cutting up stock, but working between dies should cease before this danger point is reached, even at the expense of reheating.

The compared efficiency of drop-presses and slower-driven power crank or hydraulic presses depends on circumstances and conditions, such as temperature, fluidity, elasticity, thickness of structure and mass operated upon; small articles are likely to become chilled if worked slow, while large masses require more time comparatively. It is noticeable that the slow driven "squeeze" of the hydraulic press has been in several cases substituted for the more rapid action of the steam hammer on large work with satisfactory results.

Coining.

Those of our readers who have visited museums where articles of antiquity were to be seen may have been noticed amongst the exhibits specimens of ancient coins and medals dating back several centuries before the Christian era. The process is the same now as then, our improvements being only in the direction of ways and means and nicety of execution. There is in the United States Mint, at Philadelphia, a large collection of coins, showing the various progressive steps, so far as they can be traced, from the earliest known to the present time; besides which, much else interesting to a metal worker may be seen, aside from pigs of silver and gold. Assaying, refining, alloying and casting are carried on, as well as rolling, punching the blank and milling, which consists in rounding the edges to further unify them and to remove the burr. In this condition the coins are called "planchets" or milled blanks, and are ready for the presses, into which they are usually fed automatically from a tube, a female attendant commonly being the operator. It may be readily presumed that where the raw material and finished product are alike so valuable the greatest care would be taken to prevent waste and losses. After each operation both scrap and work are carefully weighed and woe betide him or her who has a shortage.

Our American silver and gold coins are fluted or "reeded" on the edges, the operation being done at the same time the impression is made upon the sides, the internal surface of the surrounding ring or collar being fluted and very slightly conical to admit of easy withdrawal.

As the weight must remain uniform no allowance for fins can be made, therefore perfectly sharp corners are not attempted, nor are they desirable. An observation of a few coins—nickels, for instance—will show that for all the care taken, the edges are not uniform, opposite diameters on the same coin showing variations. The conditions that cause these changes are some slight misplacement of the blank in the die, spring in parts of the machine or difference of density in the metal.

Special presses are mostly used, of exceptional strength and rigidity, the toggle joint and hydraulic styles being preferred. It may be interesting to know that the average pressure used per coin is as follows: Dimes, 30 tons; quarters, 60 tons; halves, 100 tons; and whole silver dollars, 160 tons; each ton being of 2,000 pounds. Nickel coins require comparatively more pressure than silver, while copper and gold take less. The speed run is from 100 to 160 strokes per minute, according to the size of the coin.

Compressing.

Physicians and manufacturing chemists have found the process of coining adaptable to their uses, and in place of inconvenient powders and misshapen hand-made pills we can procure many of the same substances in condensed, easily portable form, divided into mechanically accurate quantities and proportions. The material is usually a dry powder, which is condensed and compressed to a point of adhesion, or in some cases moistened with a neutral substance of adhesive nature, such as glycerine, the product being in rounded disk shape or other form fancy may suggest. Soap, papier-mache, celluloid and scores of other substances are easily worked and readily formed by mold compression.

Embossing.

Perhaps it may be more proper to speak of coining as embossing, rather than molding, when stamping articles of thin metal, leather, wood, and in fact any like articles not softened artificially, albeit molds are used.

Wood embossing is practiced on small articles in place of the more costly and tedious process of routing and engraving. Ornaments for furniture, cars, cabinet work and the like are made by direct pressure, preferably on the end grain of the wood, the block being contained in such a manner in its holder or die, that during the operation the force applied tends to condense the fibers rather than separate and split them.

One method is to plane the surface down to the level of the depression formed by the dies, after the piece has been embossed, and then moisten it until the fibers have come back, nearly or quite, to their original height. This allows the design to stand out in bold relief from the planed surface and permits of its being trimmed so that quite sharp outlines may be obtained.

Much work, such as drawer pulls, handles and such articles as have a configuration that would not admit of sufficient pressure without rupture, to produce the desired shape, is roughly cut to something near the form before being operated upon by the press.

(To be continued.)

* * *

RATE OF COMBUSTION.

There has been much written of late about efficiency of steam boilers as affected by the rate of combustion of the fuel. C. Wye Williams, in "Combustion of Coal," p. 181, says: "A few words . . . on quick and slow combustion . . . time is the test of efficiency.

". . . . A rapid combustion is more economic of time, and slow combustion more economic of fuel. . . . The evaporation power of each kind of fuel is in the exact ratio of the fixed carbon contained in each."

In general, from 10 to 15 pounds of coal burned per square foot of grate per hour gives for anthracite coal a very high rate of evaporation in well-designed boiler plants; for soft coal 15 to 25 is about all that can be burned with a good chimney draft with economical evaporation. Any increase of the rates over these figures gives less economy in evaporation.

W. W. CHRISTIE.

LETTERS ON PRACTICAL SUBJECTS.

THE FRICTION OF BELTS—SMOOTH PULLEYS VS. SMOOTH BEARINGS—TESTS ON THE HAIR AND GRAIN SIDES OF BELTS.

Editor MACHINERY:

The discussion in your columns on the subject of belts calls to mind some belt tests of my own that I made some time ago. It is customary in some factories to put belts on with the flesh, or soft, side of the belt to the pulley, and in other factories the grain, or hard, side of the belt is run to the pulley. Factory owners and their superintendents are not the only ones who are not agreed as to which side of the belt should go next the pulley, for the authorities (so-called) who write on technical matters and who compile and publish pocket books for the use of engineers and others, they, strange as it may seem, have not arrived at a settled conclusion about the way a belt should be placed on a pulley rim.

To be good power transmitters belts should possess three characteristics, namely: they should be pliable, so as to conform readily to the curved surface of the pulley rim; they should have inherent strength, and should adhere to the pulley rim and not slip, for the belt that slips may get an application of belt dressing, a dose of rosin or soap, and possibly the soap dish.

The writer has seen considerable time and energy expended in making flat and smooth surfaces and journals that were round and straight, with a high degree of polish, all for the purpose of reducing friction; and yet not so very long ago he was given to understand (with some spirit and considerable force) that the smoother the surface of the pulley rim and belt the better the belt would pull, because of more friction. It was not this statement that interested me so much, however, as the publication of the same thing so frequently in technical papers. How smooth shafts and bearings could reduce friction, while smooth pulleys and belts increased it, was more than I could comprehend.

I am aware that at the present time of searching investigation one must be well fortified against the onslaught that is sure to follow any statement to the contrary of general and accepted opinion. I believed that the side of the belt that had the most adhesion was the side to run next to the pulley, and to demonstrate which side was best several tests were made. The apparatus used consisted of a pair of 25-pound spring balances, two pieces of new belting, a flat plate of iron planed smooth, as well as the different surfaces and pulleys mentioned, together with the different weights used.

Test No. 1.—The belt, which was 2½ inches wide, was placed with the hair side to the surface plate, and upon the belt was placed a weight of 100 pounds. The spring balances were hooked to the belt and a pull applied until the belt slipped, the scales showing a pull of 20 pounds.

Test No. 2.—A 50-pound weight was used, which showed a pull of 10 pounds.

Test No. 3.—The flesh side of the belt was then placed on the plate and the 100-pound weight put on, but as it required more than 25 pounds to start it, it was changed for the 50-pound weight, which showed a pull of 13 pounds to slip, this being at the rate of 26 pounds per 100 pounds, or an increase of 30 per cent. over the former test.

Test No. 4.—In this test the grain surfaces of the belts were placed together, one sliding on the other with the 50-pound weight on top, and showed a pull of 13 pounds to slip.

Test No. 5.—Flesh side of belt sliding on the grain side with the 50-pound weight started at a 13-pound pull, same as the last.

Test No. 6.—Flesh side of belt sliding on the flesh side. As the 50-pound weight showed a pull of more than the capacity of the scales a 40-pound weight was used, which required a pull of 20 pounds to start. This is at the rate of 50 pounds pull with a 100-pound weight.

Test No. 7.—The 50-pound weight on the belt with the hair side to the surface plate started at 10 pounds. The same with belt oil on the belt started at 8 pounds.

Test No. 8.—Flesh side of belt to surface plate with 50-pound weight started at 12 pounds. The same with belt oil started at 9½ pounds. In the tests when the oil was used the belt evidently slid on the film of oil, as the oil had not had time to penetrate into the leather.

Test No. 9.—The belt was placed hair side to the surface plate, and with a 50-pound weight showed a pull of 11 pounds. It was then placed on a rough casting, all else being the same, and took 20 pounds to start; but having once started, the pull would fall to 15 pounds. It was then placed on a new, hard maple floor, grain down, and with a 50-pound weight showed a pull to start of 24 pounds, and fell to 16 pounds when pulled with the grain of the floor, and when tested crosswise of the grain of the floor the pull was about 1 pound more..

Grand Rapids. Mich. G. SCHNEIDER.

* * *

STRAIGHTENING A CROOKED BORE-HOLE.

Editor MACHINERY:

The little sketch in the issue for December, by Mr. Geo. H. Waltman, on "Reclaiming a Deep Well Piston Rod" brings up a line of engineering which, though seldom noised abroad, furnishes many instances of ingenuity rarely excelled in any other branch.

While the business of drilling and pumping deep wells, like the oil wells of Pennsylvania and Southern New York, does not furnish much scope for the mathematical engineer, it does call for a class of talent of no mean order.

Some of the tools used on "fishing" jobs, though generally simple in construction, are wonders of utility, as is proved almost daily by the recovery of lost bits, etc., from depths ranging anywhere from one hundred to two thousand feet.

An instance came to the writer's knowledge of a job in this business, which was a little out of the ordinary, and, thinking that it might be of general interest, it is here given to the readers of this paper.

One of the troubles of the well driller is the liability of getting a crooked hole through faults in the rock formation, vertical seams, etc., which often throw the drill out of plumb line, and until this is corrected the drilling cannot proceed.

This driller struck a fault in limestone rock and soon had a bad hole. After trying the various expedients used in such cases he was obliged to give up until the happy idea came to his mind of burning the rock with the natural gas used in firing the boiler. A line of 3-inch pipe, carrying on its lower end a gas burner, was lowered in the well to the place of the fault. On the inside of the 3-inch pipe was a smaller pipe for the gas, the larger pipe serving as a conduit for fresh air. The gas burner at the lower end was so connected that it formed a Bunsen burner of high dimensions.

After subjecting the limestone rock to an intense heat for a number of hours, the gas was shut off and the well filled with water. The result was that the limestone rock (now quick-lime) was quickly slaked and turned to slush.

Enough being removed to correct the fault, the work of drilling proceeded without further trouble.

Corning, N. Y. FRED E. ROGERS.

* * *

THE METRIC SYSTEM—COMMENTS SUGGESTED BY PROF. SWEET'S EDITORIAL.

Editor MACHINERY:

The article on the "Metric System" and its proposed enforcement in the United States by act of Congress, from the pen of Prof. John H. Sweet, which appeared in the December number of MACHINERY, leads me to recall an article on the same topic which I contributed to "Cassier's Magazine" last year, and to repeat one or two of the points I then called attention to, and which have been especially emphasized by the experience of the past six months.

I wrote of "the metric system from a mechanical point of view," and took the ground that the metre was not nearly so good a basis for mechanical measurements as the inch, being far too large for any mechanical purposes, and that its smallest division, the millimetre, required still further subdivision before it was available for any such purposes as "close fits." I will not repeat the arguments as to the entirely unreal and inaccurate dimensions of the "metre," which was the product of one of the volcanic eruptions of the French Revolution, and was forced upon Continental Europe by the influence of France during the period of the Napoleonic wars, but which cannot be verified except by extensive and expensive geographical, astronomical and mathematical observation and calculations.

I took the ground that the inch was a measure, derived from a natural basis, its origin being found in the French name

"Ponce," a thumb, of whose usual width it is a fair measure. So the cubit, the length from a man's elbow to his finger tips, the hand, the span, and the foot are all derived from natural bases, while the yard is the length from the center of the breast to the finger tips, and the fathom the length of line a sailor or fisherman could haul in from one hand to the other.

Whatever may be the basis, it is not that point I wish to enlarge upon, but it is that the inch, as the mechanical basis of the English-speaking world, is the established standard for more than three-quarters of the machinery in use, and that the spread of English-speaking domination is going to make English weights and measures more widely used than ever.

To change now from inches to millimetres would indeed be "making the tail wag the dog"!

As Prof. Sweet says, the nations that use the metric system make their machines to come as nearly to the English standards as possible, while we are daily informed of the practice of the German machinists in copying American tools bodily, and that is much more probable that the metric nations will come to our standard, than that we shall go to theirs, as the English-speaking peoples extend their empire and their languages as they are now doing.

The main argument used in favor of the metric system is that it is decimal, and here I stated that for purposes of calculation and office work both the foot and the inches are now decimally divided, and tables of comparison, with the bisectual (not biennial) divisions, are to be found in every "Engineers' Pocketbook." Indeed, for civil engineering and outdoor work the decimals of the foot are now used entirely.

Although we acknowledge the very great convenience of the decimal system in office work, it is a very difficult thing when it comes to the practical work of construction in the shop.

Any carpenter with a pair of dividers can bisect a stick in a minute or two, and keep on until he gets down to sixteenths, which is about as far as he wants to go, but after he has made the first cut he cannot divide by 5 without long trouble, or the use of prepared scale.

The metal worker can go two steps farther, or to sixty-fourths, and this is farther than he needs to go in ordinary cases, except for fine work and "fits," for which he has scales and calipers provided.

Prof. Sweet also quotes Coleman Sellers as to the enormous expense of any such change, and emphasizes on the destruction of all English mechanical literature, to which might be added the utter ruin of every man's private notes and the abolition from his memory of all his well-known standards. It would be a far greater loss to the world than the destruction of the Alexandrian Library! Who of us is going to accustom himself to the change of "foot-pound" into "kilogrammeters" of jaw-twisting sound? Or where shall we find a convenient equivalent for the well-known and universally-used "horse-power"? The present generation has enough of a school-task to get used to volts, and amperes, coulombs and kilowatts, without loading it with a new set of uncalled-for and unnecessary impositions to suit the fancies of a class of theorists who never did a mechanical day's labor in their lives! I have corresponded with various members of Congress with whom I am personally acquainted, and all promise me to do their utmost to defeat the proposed change. Set others to do the same. SAM'L WEBBER.

* * *

STANDARD BUSHINGS FOR JIGS.

Editor MACHINERY:

An editorial in the November number, and also a contribution in the December issue, by Mr. H. M. Norris, have excited my interest to the extent of expressing an opinion and perhaps a few criticisms. To standardize bushings is certainly a move in the right direction, but why not carry the idea still farther than the editor proposes? Why should each shop establish a standard for its own particular use and employ expensive labor to "whittle" out bushings on an engine lathe when we should be able to buy them by the pound like nails?

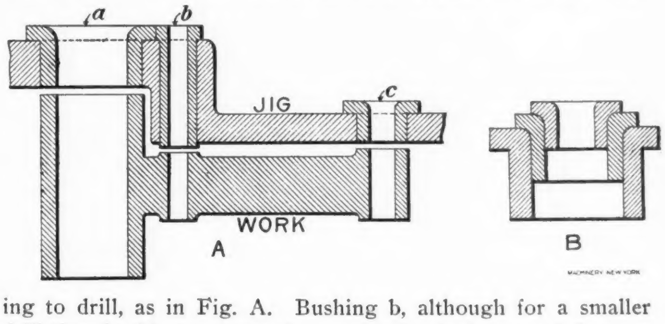
Why don't some one who has the money (not I), buy a few suitable automatic machines, adopt the standard which meets the most universal approval of the readers of this paper, and manufacture bushings and put them on the market, hardened and ground inside and out, ready for use at half their cost under present conditions, and still make 100 per cent. profit?

The editor seems to think that it would be a desirable feature to be able to interchange bushings; that is, use the same bushings for several different jigs! Right here is where he and I disagree.

To press bushings into and out of jigs would eventually wear holes so that the bushings would either turn in the jigs or run up the drill from the force of the chips gathering beneath the bushings, or the corkscrew action of the drill itself. This certainly would not add to the accuracy of the jig, and, again, what would be more exasperating than to prepare to start a job and upon applying at the tool room for necessary bushings, find that of one size needed all were in use? No; in making jigs, make them as rigid and unchangeable as possible. You will find enough variation in product under the most favorable conditions.

However, to be able to replace broken or worn bushings from stock is sufficient excuse for demanding interchangeable bushings.

Mr. Norris furnishes a table of sizes of bushings, which, although he affirms it has been in satisfactory use for several years, I must find some fault with, principally because he standardizes the lengths of his bushings. Jig bushings should project through the jig as near to the surface of work as possible, and be sure to clear. For illustration, suppose we have a cast-



ing to drill, as in Fig. A. Bushing b, although for a smaller drill than bushing a, must of necessity be the longer of the two. So, if stock bushings were made to Mr. Norris' table of sizes this job would require a special bushing. Where holes are spaced far enough apart, however, as is the case with bushing c, the outside of the jig may be offset to accommodate the length of the bushing.

And, again, Mr. Norris speaks of "nesting" bushings, which in some cases is perhaps a desirable feature, but by consulting Fig. B you will see where one comes out if he undertakes to reduce, as each smaller bushing inserted not only recedes from the surface of the work the amount of the variation of the length of bushings for different diameters, but also the combined thickness of the heads or collars of the bushings beneath it, and, by the way, I think he is making the heads of his bushings much thicker than is the general practice—certainly much thicker than is necessary.

In making up bushings for stock I should favor making heads and diameters standard, with an assortment of lengths.

CLAY-BEAU

(In writing the editorial referred to, it was designed to call attention to two classes of jigs, one of which might have bushings that were not a drive fit and could be easily removed and interchanged between different holes or different jigs; and the other of which should have bushings forced permanently in place. A careful reading of the editorial will show that this idea was set forth, even though it may not have been stated as clearly as it should have been. Of course, the latter class of jigs mentioned will far outnumber the former class in almost any shop.

We think it is an open question whether it is not better practice to use removable bushings in certain cases than to have them driven in place. In drilling flanges, engine cylinders and work of that class, where the first consideration is cost and not accuracy, a jig with one bushing, which can be changed from one hole to another, will answer the purpose very nicely, as it is an easy matter to arrange a simple lock to keep the bushing from turning or coming out. On large work it may even be an advantage to have jigs constructed in this way, as in the case of the ends of large engine cylinders, for example, where the same jig body can be used for drilling both the cylinder with a tap drill and the cylinder head with a drill large enough to make a hole that will clear the stud, a different bushing being used in each case.

Furthermore, it may even be urged that a removable bushing should be used in certain instances wher a fair degree of accuracy is required, as, for example, in drilling a large hole where it might first be advisable to put through a drill 1-16 or 1-8 inch under size, before drilling out to size. Whether this be granted or not, it is certain that jigs with fixed bushings are often so expensive that their cost precludes their use, and if it were not possible to get along without such jigs in some cases, it is probable that no jigs would be used at all for that work, and the pieces would be made year after year in the same old, expensive way.—Editor.)

* * *

A BRASS FOUNDRY REMINISCENCE.

C. Vickers.

Years have passed since I first entered a brass shop, but the peculiarities of the first one have never been effaced from my mind. Our method of warming ourselves on a frosty morning, for instance, was certainly unique if a trifle crude. We piled a heap of broad, long shavings in some clear place on the floor, and set fire to them, and in a few seconds we had a bonfire that kept us a good six feet away from it, and yet the roof never caught fire, which speaks well for its height, as such a flame will mount fifteen or twenty feet. These shavings were used to light the furnaces, which were the old-fashioned square melting holes, wholly of brick, and encased with cast-iron plates two inches thick. They were situated at one end of the shop and were raised about two feet above the level of the floor. There was no core oven, the cores being dried on the tops of the furnaces, and when dry were stored on iron shelves that were attached to the wall back of the furnaces—an admirable place to keep them, because dry and warm, but a constant source of trouble to us "kids," because whenever the foreman's back was turned, we could never resist the temptation of taking a shot at the tempting mark presented by a certain portion of the furnaceman's anatomy as he would stoop to pick up some piece of scrap, and in ten cases to one our hasty shots missed the mark and, to our consternation and the target's delight, landed among the cores, playing sad havoc. Of course no one knew how it happened when the old foreman discovered that some one had "been peggin' ag'in," so, unable to find the delinquent, he would read the riot act to the lot of us. But to return to our subject, The shop was paved with cast-iron plates, polished by time and the friction of feet, and in the center of the shop was a tank, or "bosh," as we called it. It was made of cast-iron and was about four feet square and deep. It was sunk into the ground, so as to leave about eight inches above the floor level, as a matter of precaution. It was provided with an overflow and had a water connection. We used this tank for "blowing out" our castings. The castings were shaken out and broken off the gates while hot. They were then lowered into the water with a pair of tongs, then smartly rapped against the side of the tank. The resulting explosion would free them from cores and all adhering particles of sand. Very small castings, such as valves, cocks, etc., were taken from the molds immediately after casting and tapped off the gate into a half-inch iron riddle, and when the riddle was about one-third full it was grasped by the tongs and lowered horizontally into the water. When wholly immersed we gave it a sharp upward jerk, and if the first jerk did not have the desired effect we repeated it rapidly. The whole operation must be done lively with small castings, as they cool so quickly. This is a good way to clean these small castings, as it is sometimes a tedious job to rap out the cores when cold.

A continuous bench, or trough, about three feet in height, extended around the two sides of the shop, lighted by the widows. It was five feet in breadth, and was provided with an upward inclined ledge about eight inches in height. Thus the bench was a kind of a trough. There was room for eight molders, and they worked two at a sandpile. The molds were shaken out on the floor between them, and the sand was mixed by being riddled on a pile on the bench. The molders took turns at shoveling and riddling. One would mount the bench and grasp the riddle with both hands close together, the weight of riddle and contents being supported by a rope suspended from some convenient projection, so that the riddle became a swing, and the other molder would then throw the sand up to him from the floor.

A considerable number of the patterns were carded on cast-iron plates, and on one side of the shop was a rack for holding these plates, into which they were slid edgeways. The flasks used on platework were about 12 by 18 inches, of cast-iron, and the cope was provided with three bars deep enough to reach within a half inch of the joint, being chipped out to clear the patterns where needed. The nowel was provided with two flat bars about two inches in breadth. These prevented the sand from dropping out when handling the mold, as no bottom boards or plates were used on these molds. Our method of handling them was as follows: After the nowel had been rammed, it was rolled by turning it up the inclined ledge until it stood on top in an inverted position, and was held poised on top while a sand bed was prepared down on the bench, then the nowel is lifted on it and given a twist or two to make it solid.

When the mold was finished another bed was prepared for it on the floor, and when removing the mold from the bench the bottom would be scraped along the top of the ledge, so as to strike it off and remove any portions of the first bed that might adhere thereto.

I never saw any boards in an English shop (the reader will have inferred that this was an English shop), although some may use them; instead we used cast-iron plates. They were cast very thin, and had parallel ribs to prevent warping. In that shop we used them on all our jobbing work, as these flasks possessed no bars, but in another shop that I call to mind we used no plates at all, and the benches were simply flat iron plates possessing no ledge. We rolled over our molds on the catch-as-catch-can principle, and practice made us perfect. As there was no ledge on which to rest the nowel while preparing its bed, we dispensed with this part of the ceremony, and instead we struck off our nowel, prepared a bed thereon precisely as though we intended bedding on a board or plate, but instead we simply patted over the bed with our hands, so that it would adhere while rolling over, after which a rub or two made it solid on the smooth bench. When finished we simply lifted the mold down onto the iron floor. Sometimes we had a "drop-out," but rarely. I think the sand must have been tougher than is found in American shops, as with flasks of the same size here—10 and 12-inch—it is imprudent to invert a cope without having a smooth board bedded thereon, and all flasks with straight sides have a ledge cast on at the joint to hold the sand.

But to return again to our first shop. We possessed no "upsets" or deepners to increase depth of flasks when necessary. Most of the work being standard, flasks were provided to suit. In all cases, however, where a high head was necessary to insure a sound casting we used rings or bushings on the sprue for increasing its height. We had a rapid way of making and adjusting them. We first placed the finished nowel on the floor, turned over the cope and stood it on its pins, also on the floor, or if hanging cores were longer than pins, we closed it over an empty flask. Then, placing the ring on the bench, we half filled it loosely with sand, then grasping it with both hands close together, fingers inside thumbs outside, revolved it, building up the sand inside and forming a bell-shaped head. This we placed over the sprue and united the two by giving the joint a circular sweep with the forefinger, after which we closed the completed mold. As before stated, all cores were dried on the furnace tops. Every job of molding had its "stint" for a day's work. Generally this would be accomplished by 3 o'clock, when the molders would arrange themselves seats and settle down at their benches coremaking. There was also a boy—generally an apprentice—kept busy on cores all day, but the molders made the most difficult ones. The sand used for smaller cores was called "Mansfield." It was ground in a pug mill and was of a maroon color, and so tough that no flour or rosin was used, and it was so porous that with few exceptions no venting was necessary. On large cores a coarser kind was used; it was of a bright red, was also ground and known as "Doncaster." These core sands were made to suit the requirements of different cores by being mixed in varying proportions while in the mill. To show the porosity of this sand I will cite an example of some of the cores we made without vents. One was for a bushing—a plunger we called it. These varied in size from 8 to 24 inches in length, and from 1½ inches to 4 inches in diameter, and, say, from ⅛ to ⅜ thickness; were open at one end and closed, with the exception of a ⅜-inch center hole, at the other. We cast them perpendicularly, partially closed, end upward, took a vent off from bottom of mold ,but had no vent in core and rarely had any blow.

I remember several other examples, but this article is already longer than intended.

SHOP KINKS.

A DEPARTMENT OF PRACTICAL IDEAS FOR THE SHOP.

Contributions of kinks, devices and methods of doing work are solicited for this column. Write on one side of the paper only and send sketches when necessary.

(In view of the large number of letters and kinks received each month by the editor, it is thought best to publish them under two headings instead of the one heading of "What Mechanics Think," as formerly. Accordingly the longer contributions will appear under the title of 'Letters on Practical Subjects," and the kinks and shop methods will be printed in this department of "Shop Kinks." We hope to be able to condense the matter somewhat by this method and make room for more practical ideas than ever before; and we trust that all will help on the good work with their contributions.)

A PLANER KEY SEATER.

A reader who styles himself "Uncle John," but who neglects to send us his address, forwards a sketch of a planer key seater that is similar to the one recently shown in these columns by J. T. Fink, but which he believes to be more convenient to use. The details are given in Fig. 1, where B is an angle plate with a swivel guide, E, for the cutter bar. The working face of the angle

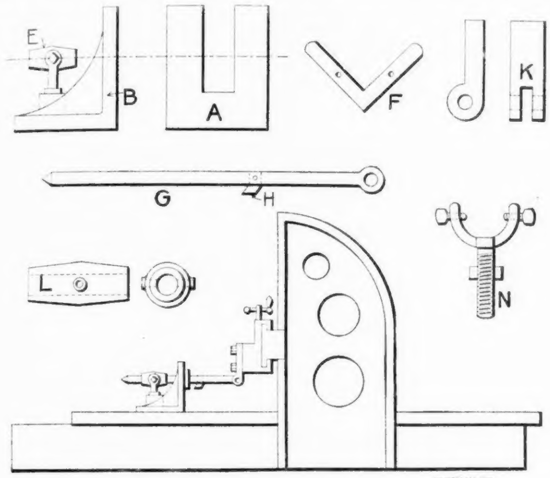


FIG. 1.

plate is slotted, as shown at A, to admit of the passage of the bar, and has bolted to it the V-block, F, which supports the work when it is being splined. The details of the guide E appear at L and N and need on explanation. The cutter bar is at G with the cutter inserted at H. The bar is supported by the holder K, which is supported by the tool block of the planer head. The angle plate is clamped to the planer table and the whole connected, as shown in the assembly view. When the key seat is cut the planer is reversed and the table run back until the bar runs clear of the work. The end of the bar is tapered so that there will be no trouble in entering it after each change.

A SIMPLE KINK.

Mr. Hugh Hill, of the Hugh Hill Tool Co., Anderson, Ind., sends the following bright note regarding C. G.'s device for lifting the planer tool on the return stroke, and which, it will be remembered, consisted of a cord carried up overhead from the tool and down to the reversing lever of the planer. He

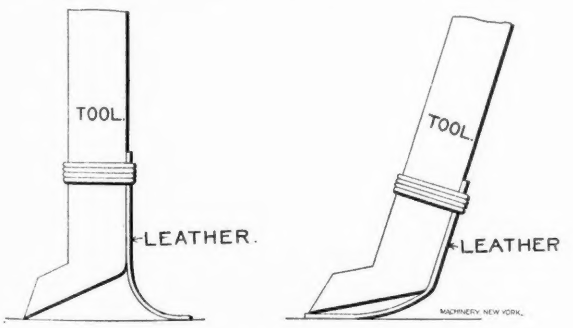


FIG. 2.

says: "I remember of having used a very similar arrangement, when a boy, for a rabbit trap, and as a failure it was a success. However, I am glad to learn of its successful introduction in the machine shop. Did Mr. C. G. ever use a piece of belt or an old hinge clamped on the back of the tool, as shown in the cut? It seems to me that these simple kinks commend themselves for their extreme simplicity. It may be that Mr. C. G. is a member of the cordage trust; if so, the universal adoption of his device would increase his income greatly."

PEN ADJUSTING DEVICE FOR DRAUGHTSMEN.

A plan often adopted by draughtsmen, in making drawings, is to ink in both shade lines and those of ordinary width as they come to them in passing over the drawing, adjusting the pen whenever a variation in the width of the line occurs. Some file a notch on the edge of the thumb screw to indicate the position that the latter must be in to produce the correct width of line and if the pen is provided with a screw having a head of large diameter, the adjustment can be easily made by a simple

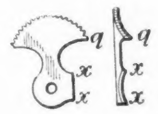


FIG. 3.

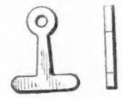


FIG. 4.

movement of the middle or fore finger. This practice leads to a rapid wear of the screw threads, however, and to overcome this and to insure uniform widths of lines with ease of adjustment, the device shown in Figs. 3, 4 and 5 was made. The description was sent us by Mr. Wm. F. Torrey, Roxbury, Mass., together with a sample which he made. It consists, first, of a lever, shown in Fig. 3, which is intended to fit on the pen under the head of the thumb screw, as indicated in Fig. 5. A movement of the lever causes the upper nib of the pen to move in or out, as the case may be, the points *x*, *x* being bent over to serve as cams. The points at *Q* are also bent over and act as

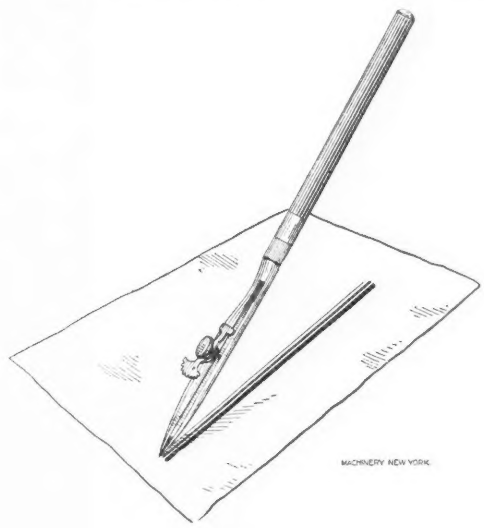


FIG. 5.

stops so that the lever may easily be brought to the same position each time and thus produce the same widths of lines.

To prevent the thumb screw from turning when the lever is moved, a washer, Fig. 4, is put on the thumb screw between the lever and the head, and the two ends are bent over the nib of the pen to keep the washer from turning.

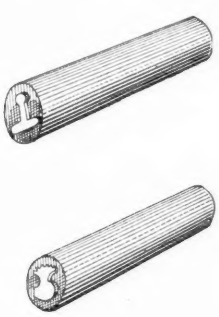


FIG. 6,

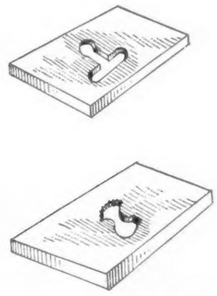


FIG. 7.

The lever and washer are punched out of sheet brass, the punches and dies being shown in Figs. 6 and 7. They are then drilled and nickeled. The device can easily be arranged to make lines of three different widths by making the points *x x*, Fig. 3, of different lengths.

GOOD FOR BURNS.

We do not claim to be proficient in medical subjects, and therefore cannot vouch for the receipt which follows: We presume it to be reliable, however, for it comes from Mr. F. H. Jackson, who has contributed many reliable kinks, and it will come in handy when one of the apprentices tries to pick up a piece of black iron just off the blacksmith's anvil or to take hold of a twist drill when it has finished drilling a long hole:

Take a 6-ounce bottle and put into it 4 ounces of olive oil and 2 ounces of lime water, adding about 25 drops of carbolic acid. Then thoroughly shake the contents; also before using. Apply to any burn and it will at once relieve the same, and produce a very cooling feeling and heal it very rapidly. This preparation is also excellent for chapped hands, etc.

REMOVABLE VISE JAWS.

A good idea in the way of vise jaws has come from "T. J.," Newton Upper Falls, Mass. It is illustrated in Fig. 8. Each jaw is made slightly shorter than the width of the jaws of the

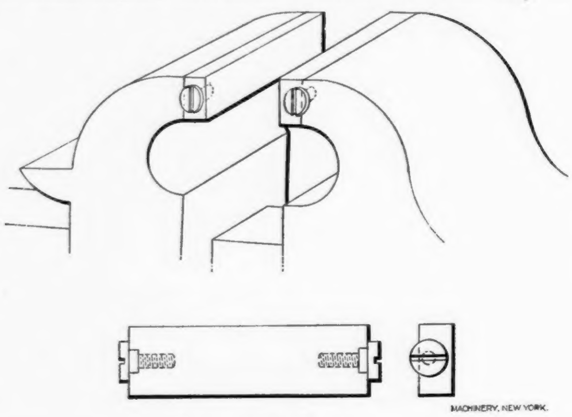


FIG. 8.

vise, and has a flat-headed screw threaded into each end, as shown in the lower part of the sketch, with part of the head overhanging on one side. In applying the jaws to the vise, unscrew the screws in the ends far enough to allow the jars to go over the vise jaws, close the vise, at the same time keeping the jaws flush with each other, and then tighten the screws against the ends of the vise jaws. The friction between the screw heads and the vise jaws is sufficient to hold the removable jaws in place.

SOMETHING NEW IN PLANERS.

W. de Sanno, Vallejo, Cal., writes that he has often wanted a planer arranged as shown in Fig. 9, and says: "You may call it an open side planer or give it any name you like, but I have no doubt that a machine built on these lines would prove a handy

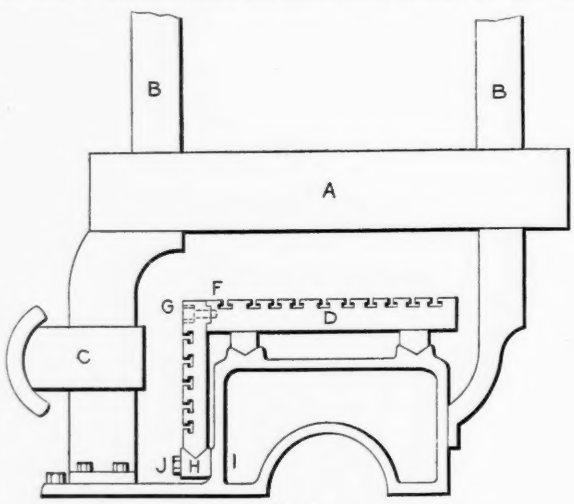


FIG. 9.

tool. The housings are marked B, B, and the left one is curved out, having the head C, as shown, to be used for any work calling it into service. In thinking out this machine I tried to avoid complicated patterns. You will notice the plates, or table D, is of the ordinary type, and to the edge or side of which is bolted the vertical, or drop, table E by a tongue and groove joint, and the countersunk bolts G. The bottom way or (H) is bolted to the side of the shears, as shown, it being the easiest and best way to support the drop table E. Now, if there are any criticisms on this tool, just 'speak out in meeting, bretherin,' as you have that privilege."

FACE-PLATE CLAMP.

When using the back rest on work in the lathe, all sorts of devices are resorted to for holding the piece operated upon against the live center, and the various arrangements are usually toggled-up affairs that have a very unworkmanlike appearance. In Fig. 10 is a sketch of a device for this purpose that has been used by a correspondent, who wishes to go by the name of J. R. S., and we think all will agree with us in saying that it is a neat and useful device to have for use on any lathe. It consists of a cast steel clamp, the threaded part of which passes through and clamps the face-plate of the lathe, while the long arm, A, bears against the face of the lathe dog that is used to drive the work. It will be noticed that the arm is inclined at an angle of 2 degrees with the body of the clamp. This is to allow the point of the clamp to bear on the dog, so that when the clamp is drawn up tight the arm will spring parallel to the face plate instead of springing out away from it, in which case it would not have so good a bearing. Mr. J. R. S. states that he finds this clamp very satisfactory, one reason being that only one hole in the face-plate is needed, instead of two, as most

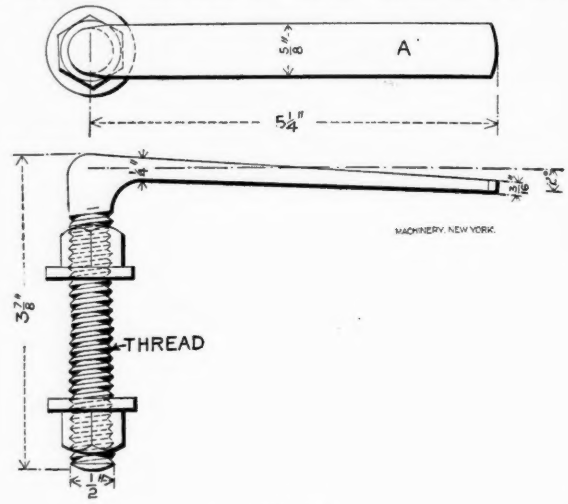


FIG. 10.

straps call for, which fact is never so much appreciated as when using a small face-plate with only two slots, the dog occupying one of them. Another reason is that there are no projecting bolt heads or nuts, which is a great convenience when driving a short piece. The size shown can be used on almost any job coming within the limits of 16-inch lathe.

* * *

FLY-PRESS GUARDS.

Editor MACHINERY:

A good many persons who deem themselves ordinarily careful have had a clip alongside of the head or elsewhere from the ball of a fly-press, such as is used in stamping metals, soap, etc. The machine tender himself sometimes gets a reminder of this sort, and accidents more or less painful or serious have occurred through a chain, rope or other swinging or projecting object getting right in the orbit of the swiftly rotating but slowly descending weight. ("Mass" is probably the correctly technical word, but we will let it go at that.)

In one German shop which I have recently visited, and where they are stamping out a good deal of bicycle work, such accidents are largely prevented, and arnica and profanity saved, by a circular guard, consisting of a simple stout hoop of band iron fastened at opposite ends of a diameter to the equators of the balls, so that, as far as heads and shoulders are concerned, it would require some little skill to succeed in getting thumped. I recommend the "wrinkle" to those using fly-presses as cheap and effectual. ROBERT GRIMSHAW.

* * *

Probably the largest order for water tube boilers that was ever placed in this country is a recent order which the Cramp Co., Philadelphia, has given to the Stirling Co., of Chicago, for water-tube marine boilers for the Russian war ships that are now being constructed at the Cramp yards, amounting to about 35,000 HP.

PRACTICAL PROBLEMS.—3.

PROBLEMS 5 AND 6, WITH ANSWERS TO PROBLEMS 1, 2, 3 AND 4.

[Solutions should be forwarded at the earliest date possble to secure publication.)

Problem 5.—A Question of Angularity.

Joe Thompson, machinist at Bodley's shop, was sent one day to Thatcher's mill to take out the connecting rod of a small center crank engine which had been doing duty without its just proportion of that which lubricates and was in consequence in dire need of some new brasses.

It happened (never mind how) that the crank was on the exact top quarter point when the rod was disconnected, and the crosshead was left undisturbed in the position it had occupied before the rod was touched.

After the connecting rod was removed the sizes of the wrist pin and crank pin were taken and found to be 2¼ and 3 inches in diameter. While taking the diameters the shaft was turned so that the crank pin was on the center next to the cylinder and Joe noticed that his 2-foot rule, when opened to its full extent, would just measure the distance between the wrist and crank pins, in this position.

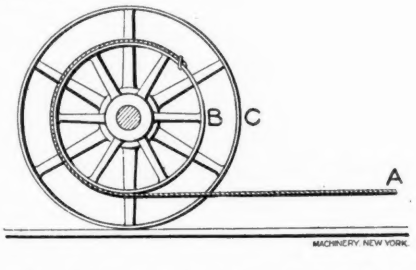
Upon returning to Bodley's shop to fit up the new brasses, the length of the connecting rod was measured and found to be 31⅞ inches between centers, and a discussion arose as to the stroke of the engine.

Joe had not measured the stroke, but allowed that he could tell from the measurements taken, intentionally and accidentally. After working at it for some time, he got stuck in his figures and had to give it up, but he still believes it can be done.

Perhaps some of the readers of this paper can tell what the stroke is from this meager data and how to get it, and also what the effect of the angularity of the connecting rod is on the position of the crosshead—that is, how far from the center of the stroke was it when the rod was disconnected?

Problem 6.-A Lesson in Pulleys.

The following simple problem has bothered many a shopman as well as others, in an offhand answer, and although the correct result can be easily found by a practical experiment, it is well to understand and fix in the mind the principle in mechanics which is involved.



A counter-shaft has at each end a pulley 3 feet in diameter, and between the two is another one 2 feet in diameter.

The sketch shows the countershaft lying on the shop floor, and only shows one of the large pulleys *C*. A cord is wound around the pulley *B* and carried out to the right.

Now, if the end of the cord *A* be pulled to the right, parallel to the shop floor, a distance of 6 feet, how far and in what direction will the whole countershaft move?

ANSWERS TO PROBLEMS 3 AND 4.

The following answers have been received to the problems given in the December number:

Mr. Elmer G. Eberhardt, of Newark, N. J., again sends solutions as follows:

Problem 3.—The extremity of the handle K moves with a force of 50 lbs in the circumference of a circle of 16 inches radius, or through 100.5 inches for each revolution. This moves the piston F ⅛ inch, which in turn moves the piston E, $\frac{.8^2}{2^2} \times$ ⅛ inch = .02 inch, the ratio or leverage of H and I being proportional to their areas or to the squares of their respective diameters, .8 inch and .2 inch.

When the piston E moves .02 inch the handle K moves 100.5 inches with a force of 50 pounds. Hence the piston E moves with a force found as follows: $\frac{100.5}{.02} \times \frac{x}{50}$, whence x = 251,250 pounds, which is the theoretical pressure on piston E; but the efficiency being 25 per cent., the actual or available pressure is $\frac{251{,}250}{4} = 62{,}812.5$ pounds.

Problem 4.—Draw the circle D C F with a radius of 2½ inches. Draw the radii A D and A F, and also draw A C perpendicular to D F. Whence from geometry we know that it divides D F into two equal parts, D E and F E. Now call E C a, then D E = E F will equal 2a, and D F will equal 4a (from the conditions of the problem).

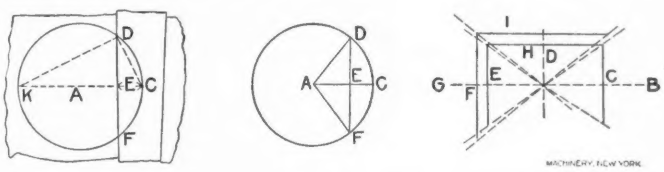
The triangle A D E has a right angle at E, hence $AD^2 = AE^2 + DE^2$. Now A D = 2½ inches and A E = A C — E C = 2½ — a; also D E = a.

Therefore $(2½)^2 = (2½\text{-}a)^2 + (2a)^2$, from which we find the value of a to be 1 inch, or E C = 1 inch and D F = 4 E C, or 4 inches, which completes the solution.

Mr. W. L. Graffam, of Worcester, Mass., in his solution of problem 4 brings out clearly the principle of geometry referred to. His letter is as follows:

I will begin with two principles of geometry which I think are unnecessary to prove.

The first is: Any triangle inscribed in a semi-circle with the diameter for one side is a right angled triangle. Therefore by drawing K D and D C we have K D C, a right triangle and angle K D C is a right angle.



The second principle is: If in any right triangle a line be drawn from the right angle perpendicular to the hypotenuse, this line will be a mean proportional between the two portions of the hypotenuse thus divided.

Thus D E is a mean proportional between K E and E C, that is,

$$E\,C : E\,D = E\,D : E\,K, =$$
$$E\,D^2 = E\,C \times E\,K \quad \text{......................} (1)$$

Now let E C = x and K C = d, the diameter of the circle.

Then from the conditions of the problem D F must equal 4 x and D E = 2 x.

Hence from our equation (1) by substitution we have $x \times E\,K = 2x \times 2x = 4x^2$.

But E K = d — x,

Then $x\,(d - x) = 4\,x^2$.

$$d\,x - x^2 = 4\,x^2.$$
$$d\,x = 5\,x^2.$$
$$d = 5\,x.$$

Therefore $x = \frac{d}{5} = 1$ inch, since in the above problem d = 5 inches.

$$5 - 1 = 4 \text{ inches length of D F.}$$

Answers to Problems 1 and 2 received too late for Publication Last Month.

While the answers published in the December number are sufficient to show the method of solving the two problems, the following two are here presented, which, for their elegance and simplicity, are to be commended.

Mr. W. E. Hunter, of Covington, Ky., sends correct solutions to both, but the answer to No. 1 will only be given here.

The first problem given in the November issue may be solved as follows:

Suppose the arm on sleeve D to make one revolution, then will the gears I and H have made 40-60, or 2-3 of a rotation. The rotative effect of H on E is $-\frac{2\text{-}3 \times 50}{32}$, effect caused by its revolution is + 1 and the total effect on E is $1 - \frac{2\text{-}3 \times 50}{32} = -\frac{1}{24}$.

The rotative effective of H on C is $+\frac{2\text{-}3 \times 50}{31}$, the effect caused by revolution is + 1 and the total effect is $1 + \frac{2\text{-}3 \times 50}{31} = \frac{193}{93}$.

The ratio consequently is 193-93 : — 1-24 = 1 : — 31-1,544, or as 1,544 is to 31 and the rotation of E is negative.

The second solution is of No. 2, by Mr. Jas. Dangerfield, of Elgin, Ill.

The force given in next to last paragraph is evidently a misprint, and should be 141.372 pounds.

Area of A, $.7854 \times 4^2 = 12.5664$ sq. in.

Area of B, $.7854 \times 5^2 = 19.635$ sq. in.

Difference in areas of A and B = 7.0686 sq. in.

Pressure in C against difference of areas is $7.0686 \times 40 = 282.744$ pounds. The difference between 282.744 pounds and 141.372 pounds = 141.372 is the amount of pressure through E against B in excess of that through D against A.

Let 8 x = pounds pressure per sq. in. through E
and 11 x = " " " " " D

$$(8x \times 19.635) - 141.372 = 11x \times 12.5664$$
$$157.086 - 141.372 = 138.2304\,x$$
$$18.8496\,x = 141.372$$
$$x = 7.5$$

8 x = 60 pounds per sq. in. through E
11 x = 82.5 " " " D

Mr. Frank E. Wilder, of Providence, R. I., sends an excellent and thorough analysis of problem 1, in which he brings up the question of how is it possible to have the gears C and E of 31 and 32 teeth and mesh to their pitch lines without making them of a slightly different pitch. He also says: "In such movements as this a change of a tooth or two often causes astonishing results. For instance, let E have 33 teeth, I 59 and F 39; then the same reasoning as applied above, will show that C must make nearly 1341 rotations to one of E.

In the gear problem the sketch showed the axis of H and I as being at right angles to that of G. B., but it really is inclined to the right, as shown in this outline, but the amount is small, being equal to one-half the difference in diameters of the two gears F and C, and as this was only one tooth, the angle would be hardly perceptible in a drawing. It will also be seen that although the gears all apparently have a common center angle it is not necessary that the angle of H and I be equal or that of F and E, as assumed by one correspondent. If he will reflect on this point he will see that if this were the case there could be no differential movement, and that the result of rotating B, while it would swing the sleeve D around its axis, could communicate no movement to the shaft G.

FRED E. ROGERS.

* * *

The method is adopted in many shops of numbering the different machines for convenience in designating the machine that is used for a particular job or operation. When the workman makes out his time card he indicates by number the machines worked on and the records thus kept show the relative value of the different machines and tell at a glance how many machines were run at once, and what ones they were. The difficulty with the system, however, is that unless one is very familiar with all the tools in the shop, he cannot tell at a glance what kind of a machine was used; whereas, if the workman had written "planer" or "milling machine" it would be known at once which kind it was, and the information depending on that fact would be forthcoming. To avoid this difficulty and to retain at the same time the advantages of the numbering system, it seems like a sensible suggestion that the different classes of tools be designated by numbers between certain limits, just as the floors of an office building or the blocks of a city are numbered by hundreds. Thus, in a small shop, lathes might be designated by numbers below 100; planers and shapers by numbers from 100 to 150; milling machines by numbers from 150 to 200, etc. This would be simpler than using some other symbol besides the number to indicate the kind of machine and would answer every purpose.

* * *

Mr. Arthur Herschmann, mechanical engineer, who has recently come to this country, writes us that he has been engaged by William Sellers & Co., of Philadelphia, as a representative engineer. Mr. Herschmann has had an extensive experience abroad, both in England and on the Continent, in constructive work as well as in other branches of mechanical engineering, in which he has been very successful; and we trust that he will meet with a like degree of success in this country.

THE BURSTING OF SMALL CAST IRON FLY-WHEELS.*

EXPERIMENTS ON FLY-WHEELS 15 INCHES AND 24 INCHES IN DIAMETER, WITH SEVERAL DESIGNS OF RIM.

Of late years the failures of large flywheels have become alarmingly common. Every month brings its record of one or more disasters of this sort, some of them entailing loss of life and serious destruction to property. It is not the purpose of this paper to discuss the causes of such accidents, further than to notice the fact that the high belt speeds and close regulation required in electric plants have been indirectly responsible. Many of the flywheels have failed on account of excessive speed due to disarrangement of the governor and consequent racing of the engine. In some instances it has been difficult to determine the cause on account of the destruction and excitement at the moment. In no small number of instances, however, the wheels have burst at speeds but slightly above the normal, and when the factor of safety was apparently ample.

Mr. James Stanwood, of this society, was the first to point out the condition of stress existing in a flywheel rim and to show that the bending, due to centrifugal force might reduce very materially the bursting speed. This subject was further developed by Professor Lanza, and the probable amount of stress due to bending was indicated, as well as its effect upon rim joints. It occurred to the writer that a series of experiments on small cast-iron wheels might throw some light on the causes of failure and lead to more rational formulas for designs.

The quality of the metal in a small wheel is better than in a large, and the stresses due to uneven cooling are much less. The linear speed of rim at which a large wheel will burst will therefore be less than that obtained by experiments on small wheels.

The experiments about to be described were conducted under the immediate direction of the writer at the laboratories of Case School of Applied Science, and he was present at the bursting of nearly every wheel. Acknowledgment should be made of the services of the students who carried out the experiments, Messrs. Bishop and French, of the class of '97, and the Messrs. Emrich, of the class of '98. Without their intelligent and faithful assistance the work could not have been done.

The wheels were all of cast-iron and were clean, perfect castings. Two diameters were used, fifteen and twenty-four inches, and each wheel was a scale model of some actual flywheel designed by a reputable firm. The wheels numbered 1 to 10 had solid rims, with the exception of No. 5. Wheel No. 11 was a special wheel, as will be explained later. The wheels numbered 12 to 17 had each two joints in the rim, and were 24 inches in diameter. All the wheels numbered from 1 to 10 were reduced models of a solid rim flywheel 10 feet in diameter now in use on a 12 x 30 Allis-Corliss engine in the laboratory. The wheels numbered 12 to 15 were models of the same wheel on a larger scale, with rim joints designed by the writer. The two wheels numbered 16 and 17 were models of the flywheel of a Corliss blowing engine. Tables I., II. and III. give the dimensions of the wheels.

To give to the wheels the speed necessary for destruction, use was made of a Dow steam turbine capable of being run at any speed up to 10,000 revolutions per minute. The turbine shaft was connected to the shaft carrying the flywheels by a brass sleeve coupling, loosely pinned to the shafts at each end in such a way as to form a universal point, and so proportioned as to break or slip without injuring the turbine in case of sudden stoppage of the flywheel shaft.

One experiment with a shield made of 2-inch plank convinced us that safety did not lie in that direction, and in succeeding experiments with the fifteen-inch wheels a bombproof constructed of 6 x 12-inch white oak was used. The first experiment with a twenty-four-inch wheel showed even this to be a flimsy contrivance. In all subsequent experiments a shield made of 12 x 12-inch oak was used. Even this shield was split repeatedly and had to be reinforced by bolts. The brick piers of the basement furnished havens of refuge for the experimenters and no accidents occurred, but sundry holes in the brick wall, broken hangers and riddled belting remain as souvenirs of the spiteful force of the flying fragments. The wheels were usually

* Abstract of paper by Chas. H. Benjamin, read at the New York meeting of the American Society of Mechanical Engineers.

demolished by the explosion. No crashing or rending noise was heard, only one quick, sharp report, like a musket shot.

The determination of the speed offered some difficulties at first, it being too great for the successful use of a counter or tachometer. A commutator of one break was arranged on a flywheel shaft and this connected through the battery circuit with an earphone in an adjoining room. This arrangement worked satisfactorily, giving a clear, musical tone, and the number of vibrations corresponded closely to the speed as measured by a reducing counter shaft and speed counter. It was soon discovered that the audible tone produced by the machine itself when running at a high speed corresponded exactly to the tone in the earphone, and consequently the earphone was discarded. Two observers, having trained musical ears, and provided with tuning forks, had no difficulty in determining the pitch within half a tone, the quarter tones being estimated. The error due to this method did not exceed five per cent., and was probably less than if an attempt had been made to get the speed with a tachometer. The bursting speed of the wheels having rim joints was too low to produce a musical tone with any distinctness and it became necessary to resort to the tachometer. It was not deemed safe for the observers to apply the instrument directly to the flywheel shaft, and a counter shaft reducing the speed from two to three times was employed. Wooden pulleys were used, connected by a band consisting of several thicknesses of electrical tape. Careful observations convinced the writer that there was no appreciable slip.

TABLE I.

No.	Rim.					Arms.		B'rsting Speed.	Cetrifugal Tension
	Style.	Diam., Inches.	Br'dth, Inches.	Depth, Inches.	Area, Sq. Ins.	No.	Area, Sq. Ins.	Revs. per Minute.	
1	Solid	$15\frac{1}{8}$	2	.70	1.4	6	.46	6,525	18,500
2	"	$15\frac{1}{8}$	2	.65	1.3	6	.46	6,525	18,500
3	"	15	2	.615	1.23	6	.46	6,035	15,600
4	"	$14\frac{13}{16}$	2	.52	1.04	6	.46	5,872	14,400
5	Sectional	$15\frac{3}{32}$	..	....	....	6	.46	2,925	3,700
6	Solid	$15\frac{3}{32}$	2	.69	1.38	3	.46	5,600	13,600
7	"	15	2	.615	1.23	3	.46	6,198	16,500
8	"	$14\frac{3}{4}$	2	.475	.95	3	.46	5,709	13,600
9	"	$14\frac{5}{8}$	$1\frac{7}{8}$	.400	.75	6	.46	5,709	13,300
10	"	$14\frac{1}{2}$	$1\frac{7}{8}$	.347	.65	6	.46	5,709	13,000

were turned down thinner. No. 3 burst at a speed of 6,035 revolutions per minute, or a rim speed of 395 feet per second. No. 4 at 5,872 revolutions per minute, or 380 feet per second. The rims being thinner, bent more between the arms, so that the rims failed at a less speed. The shape of fracture at the outer ends of the arms in all the wheels usually indicated that the rim broke first midway between the arms, and that then the two parts of the rim flew outward and broke off at the arm.

Wheel No. 5 had two joints in the rim at opposite extremities of a diameter. The strength of the joint was designed to be one-third the tensile strength of the solid rim, but the wheel burst at only 2,925 revolutions per minute with a centrifugal tension of less than one-fourth that of the solid wheels.

Nos. 6, 7 and 8 had only three arms, every other arm having been removed from the pattern before casting. The object of this was to show more clearly the bending of rim due to centrifugal force. These three wheels burst at speeds of 5,600, 6,200 and 5,709 revolutions per minute respectively. The figures for No. 6 were obtained with a tachometer and are doubtful, being probably too low.

Wheels No. 9 and 10 were of the original six-armed type, but with rims turned down to exceeding thinness, as shown in Table I. They each burst at a speed of 5,709 revolutions per minute, or at rim speeds of 365 and 361 feet per second, respectively, a reduction of over 16 per cent. from Nos. 1 and 2.

These results are summarized in Table I. A calculation of the velocity in feet per second will show that as the segments of the rim between the arms become weaker as beams, either through increase of length or decrease of thickness, there is a falling off in the bursting speed.

To determine to what extent the strength is affected by bending, the centrifugal tension has been calculated. As has been shown by Mr. Stanwood in the paper before referred to, this expression represents approximately the tensile stress on the square inch of the section of rim, due to the centrifugal force, for cast-iron. By comparing these values with the tensile strength of the iron before noted, viz., 19,000 pounds per square inch, the amount of stress due to bending may be estimated. This difference varies from 500 pounds per square inch in Nos. 1 and 2 to nearly 6,000 pounds per square inch in Nos. 9 and 10—being greatest in the wheels with thin rims or few arms. None of these wheels, however, except No. 5, would have been unsafe at the usual limit for flywheel rims of 100 feet per second. Wheel No. 10 would have had a factor of safety of over 12 at that speed.

TABLE II.

No.	Shape and Size of Rim.					Flanges.			Bolts.			Bursting Speed.	Cent. Tension.	Remarks.
	Diam., Inches.	Breadth, Inches.	Depth, Inches.	Area, Sq. Ins.	Style of Joint.	Thickness, Inches.	Effective Breadth, Inches.	Effective Area, Inches.	No. to Each, Joint.	Diam., Inches.	Total Tensile Strength, Pounds.	Rev. per Min.		
11	24	$2\frac{1}{8}$	1.5	3.18	Solid rim.	..	....	....	..	..	......	3,672	47,000	Solid rim.
12	24	$4\frac{1}{16}$	.75	3.85	Internal flanges, bolted.	$\frac{11}{16}$	2.8	1.92	4	$\frac{5}{16}$	16,000	.....	......	Flange broke.
13	24	4	.75	3.85	" " "	$\frac{11}{16}$	2.75	1.89	4	$\frac{5}{16}$	16,000	1,760	13,100	Flange broke.
14	24	4	.75	3.85	" " "	$\frac{15}{16}$	2.75	2.58	4	$\frac{5}{16}$	16,000	1,875	14,800	Bolts broke.
15	24	$4\frac{1}{16}$	.75	3.85	" " "	$\frac{15}{16}$	2.5	2.34	4	$\frac{3}{8}$	20,000	1,810	13,900	Flange broke.

TABLE III.

No.	Shape and Size of Rim.				Lugs, Area Sq. Ins.	Links.		Rim, Net Area.	Strength of Links, Lbs.	Strength of Rim, Lbs.	Bursting Speed, Rev. per Min.	Centrifugal Tension.	Remarks
	Diam., Inches.	Breadth, Inches.	Depth, Inches.	Area, Sq. Ins.		No. Used.	Area, Sq. Ins.						
16	24	1.2	2.1	2.45	.45	3	.186	1.98	30,540	38,800	3,060	25,100	Rim broke.
17	24	1.2	2.1	2.45	.43	2	.205	1.98	20,360	38,800	2,750	20,600	Lugs and rim broke.

The tachometer used was of the usual rotary pendulum type and was calibrated several times by comparison with a speed counter.

Fifteen-Inch Wheels.

Test pieces cast from the same ladle as these wheels were broken in the testing machine, and the following average values obtained for the breaking strength:

Tension, 19,000 pounds per square inch.

Cross-breaking, 39,000 pounds per square inch.

These wheels were all turned on the face and edges of the rim, and were carefully balanced by winding copper wire around the arms near the rim.

Wheels Nos. 1 and 2 were practically identical in size and shape, as may be seen by Table I., and broke at the same speed, viz., 6,525 revolutions per minute, or a rim speed of 430 feet per second.

Nos. 3 and 4 were similar to the preceding, save that the rims

Twenty-four Inch Wheels.

All the wheels numbered from 11 to 17 were of the above diameter. No. 11 was a special wheel which had been in actual use. This wheel burst at 3,670 revolutions per minute, or a peripheral speed of 385 feet per second, which corresponds well with the average speed of the 15-inch wheels. The explosion was very violent and completely wrecked the shield. The quality of the iron was unknown, save that it appeared clean and close-grained.

The wheels numbered 12 to 15 were of the same model as the 15-inch wheels on a larger scale, but each wheel had two internal flange joints in the rim, midway between the arms. The joints were all carefully planed, and the holes drilled to match.

The wheels were not turned on the face, but were balanced the same as the others. In none of the experiments was there any shaking or tremor, only a dull roar of increasing intensity, then a single, sharp report, and quiet, except for the hum of the relieved turbine.

The proportions of the flanges and bolts are given in Table II. The bolts used were of steel, and samples of each broken in the testing machine gave the results shown in the table.

Wheel No. 12 burst at a speed of less than 1,800 revolutions per minute, but the exact speed was not recorded. The flanges broke, but the bolts were uninjured, except for a slight stretching.

No. 13 was a duplicate of No. 12 in every way, and burst at 1,760 revolutions per minute, or 184 feet per second. The bolts were uninjured but the flanges broke through the bolt holes. The flanges of the pattern were then strengthened by adding 1/4 inch to the thickness, the bolts remaining the same.

Wheel No. 14 burst at 1,875 revolutions per minute with a rim speed of 196 feet per second, in this case the bolts failing.

In No. 15 bolts 3/8 inch in diameter were used, and the wheel failed at 1,810 revolutions per minute, or a rim speed of 190 feet per second. In this experiment the flanges of one joint were badly broken, the bolts remaining whole. The second joint was uninjured, as in No. 14.

In Table II. it will be noticed that the rim speed is about one-half that of a solid wheel, and therefore the centrifugal tension about one-fourth. The joints in all the wheels were carefully made, and were relatively stronger than many joints in fly-wheels which are running to-day in our mills and shops. The centrifugal tension at the joint would be greater than that given in Table II., on account of the weight of flanges and bolts. At a rim speed of 100 feet per second these wheels would have a factor of safety of about 3 6-10, which is altogether too small.

Linked Joints.

Wheels numbered 16 and 17 were of the familiar rolling-mill type, with the joints connected by steel links over cast-iron lugs, the links being heated and shrunk on.

The dimensions of the lugs and links are given in Table III.

Wheel No. 16 had three links to each joint, one on each face and one inside. This wheel burst at a speed of 3,060 revolutions per minute, or 320 feet per second. Each joint broke on one side, through the rim, without shearing the lugs or breaking the links.

In No. 17 the link was omitted from the inner lug, leaving but two links to each joint. This wheel burst at a speed of 2,750 revolutions per minute, or 290 feet per second. On one side the rim broke as in No. 16; on the other side the lugs failed by breaking off. It is impossible to say which joint failed first. It is thus seen that No. 16, with three links, broke at a speed 66 per cent. in excess, and No. 17, with two links, at a speed over 50 per cent. in excess of that of the wheels with flanged joints.

From the summary in Table III. it will be noticed that the strength of the rim at the weakest section is apparently in excess of the strength of the links, whereas it was the rim that failed in each case. It must, however, be remembered that the links were under direct tension, while the rim was subjected to bending in addition.

At 100 feet per second the factors of safety for Nos. 16 and 17 would be 10 1/4 and 8 4-10 respectively.

Conclusions.

1. Fly-wheels with solid rims, of the proportions usual among engine builders and having the usual number of arms, have a sufficient factor of safety at a rim speed of 100 feet per second if the iron is of good quality and there are no serious cooling strains.

In such wheels the bending due to centrifugal force is slight, and may safely be disregarded.

2. Rim joints midway between the arms are a serious defect and reduce the factor of safety very materially. Such joints are as serious mistakes in design as would be a joint in the middle of a girder under a heavy load.

3. Joints made in the ordinary manner, with internal flanges and bolts, are probably the worst that could be devised for this purpose. Under the most favorable circumstances they have only about one-fourth the strength of the solid rim and are particularly weak against bending.

In several joints of this character, on large fly-wheels, calculation has shown a strength less than one-fifth that of the rim.

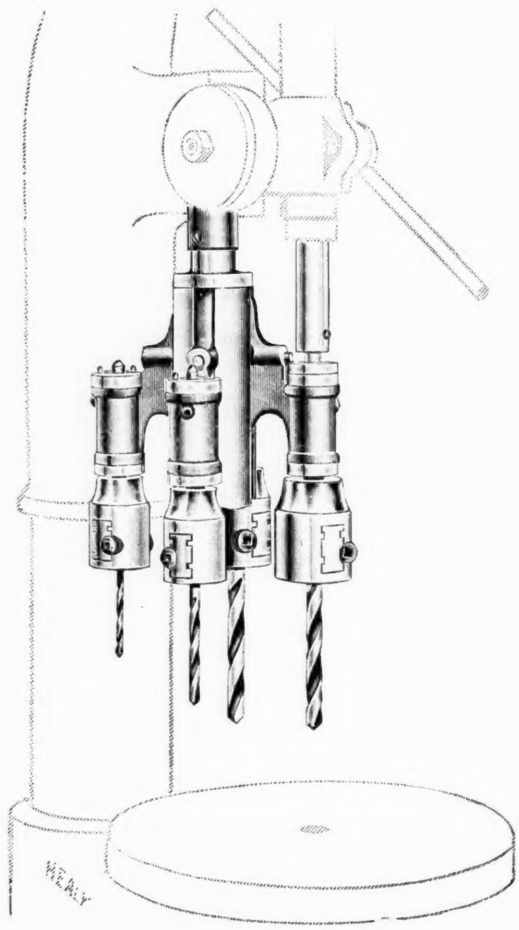
4. The type of joint exemplified in Nos. 16 and 17 is probably the best that could be devised for narrow-rimmed wheels not intended to carry belts, and possesses when properly designed a strength about two-thirds that of the solid rim.

It is gratifying to notice the fact that since the subject of joints in fly-wheels has been so thoroughly ventilated during the discussions before this society, several of our prominent engine builders have changed the designs of their wheels by bringing the rim joints opposite the ends of the arms.

* * *

TURRET ATTACHMENT FOR DRILL PRESS.

The accompanying illustration shows a turret attachment that has recently been brought out for use on upright drills. It can be applied to nearly any design of upright drill, and will be found particularly useful in jig work or in manufacturing operations where a large number of holes of different sizes must be drilled in the different pieces that are being operated on. It will be equally useful in shops where the expense of a gang drill is too great, or where the work is of such size that it is easier to shift the drill spindles than to move the pieces from one drill to another. It is in accordance with the modern idea of bringing the machine to the work rather than the work to the machine.



TURRET ATTACHMENT.

The heads are held up in their usual position by a pin and spring. When the drill spindle is brought down, it connects with the head under the drill spindle, and as the spindle goes down it unlocks the head from the cylinder and at the same time locks the head to the driver in the drill spindle, and remains locked until the drill spindle is carried back to its usual position, when it unlocks of itself and locks into the cylinder. The cylinder is turned by a slight touch and the next head will stop exactly under the drill spindle. When one of the heads is locked to the drill spindle, it really becomes a part of that spindle, and very little if any strain comes on the slides in the cylinder. The cylinders can be made long enough to take all the run of any spindle in any drill press, and the heads can be made to swing any size. The heads on the turret, shown in cut, have a run of 4 inches each, and the turret from center on head

to center opposite is 5½ inches,or 7 inches over all. The spindle in each head is ¾ inch diameter, 2¼ inches long. The ends of spindles can be fitted to universal chuck, like the cut, or bored out for straight or taper shank drills. The attachment is made by the Geo. Burnham Co., Worcester, Mass.

* * *

NOTES FOR APPRENTICES.

Bell Crank.

THREADING CHUCKED WORK.

All engine lathes have at the back end of the spindle an adjusting screw or other device for taking up end play of the spindle, but the apprentice might run a lathe some time before finding any use for it or even suspecting its value, for all work turned on centers crowds the spindle back and takes up the lost motion so there is no difficulty. When work is held in a chuck or on a face plate it is impossible to cut a good thread on it with a thread tool if the spindle has any end motion, for when the tool comes up to the work it first crowds the spindle back as the front edge begins to cut and as soon as both edges are cutting full the spindle is almost sure to have end motion caused by variation of the material, which permits the tool to nose around in the line of least resistance. The first thread on the end of the piece is nearly always thicker than the others. While an apprentice I cut internal threads in a number of caps, and then chucked one of the pieces they were to be fitted to and cut an external thread, using one of the caps to try on, but when it was threaded small enough to screw on I was wonderfully surprised to find that, after being screwed on one turn, the fit became so loose that it rattled around in a way which made sad music for me. It was the thick front thread in the cap and on the plug that did the business.

For work of this kind the end adjustment should be as tight as the spindle will permit without heating or cutting. When doing external threading the lost motion can sometimes be taken up by the tail center against the piece directly or with the end of a mandrel against it.

MAKING CALIPER FITS.

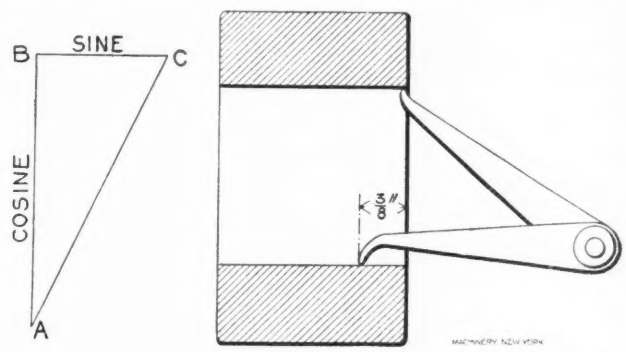
Nearly all good apprentices have a proper ambition to become able to determine sizes with calipers, so two pieces will fit each other as desired. Only a small percentage of machinists can do this with the serene confidence of the expert, who has no haunting uncertainty until he knows the pieces have been tried together, but who does not care when or where this is done, because he knows they will fit. Writers nearly always say that this art may be mastered by anyone with a delicate sense of touch and sufficient practice, but there is a mental process essential to it which, if not clearly understood, will cause failure, no matter how good the sense of touch or amount of practice. It is to this part of the operation I wish to call particular attention, and I will try to explain it by an example.

Suppose it is desired to bore a hole to fit a shaft. First, caliper the shaft as usual, keeping clearly in mind just how hard the calipers touch the shaft when finally adjusted to suit the sense of touch; now set the inside calipers so that when the calipers are tried together the outside ones will touch just exactly as hard as they did on the shaft, first trying on the shaft and then on the inside calipers, until you are sure they touch the same. This is important, and until the operator can do this correctly the whole thing will be guess work. The perfect result of this operation is that you now have the inside calipers set to the exact size of the shaft. Having this, it is comparatively easy to do the rest, for you only have to consider, if you wish to have the shaft go easy in the hole, the inside calipers must go in just as easy, or if it must be a snug fit the calipers must fit the same. In fact, you can imagine the inside calipers to be the shaft in your hand and you are trying it in the hole. When it comes to boring for a shrink or driving fit, allowance is usually made from experience, but in another note I will show how the inside calipers may be used to get the desired size.

When sizing a piece to fit a hole, the process is the same, the outside calipers being set to touch the inside ones, the same as they touched the hole, and then the outside ones carry the exact size of the hole, which may be tried on the shaft.

BORING THE SIZE FOR A SHRINK OR DRIVE FIT.

After setting the inside calipers, as described in another note, the problem is to use them to determine the diameter of a hole, which is to be a definite size smaller than the calipers. This may be done by taking advantage of a little geometry. Suppose the diameter of a shaft to be 8 inches and for a forced or shrink fit it would be good practice to make the hole 8-1000ths smaller than this. By reference to the sketch note that line *A-B* is square with line *B-C*. Let *A-C* be the size of shaft 8 inches, and *A-B* the diameter of bore 7 992-1000 inches; then, by geometry distance, *B-C* would be 358-1000ths, or nearly ⅜ inch. If the hole is bored so the calipers will go in it as shown in the sketch, and the hub is faced square with the hole, it represents the conditions shown by the triangle and the hole will be the desired size. Of course, it is apparent the points of the calipers must be small and spherical shaped for such work, but it is obvious that even with this practical limitation, it is better than the old familiar way of holding the calipers up together and



guessing at the allowance by the amount of light seen between the points. If it is desired to size a shaft to fit a given hole, the inside calipers may be set in the hole as shown, and they will then be the desired size of the shaft. As the distance *B-C* is proportional to *A-C*, for all sizes, it follows that for a 1 inch shaft *B-C* would be ⅛ of that for an 8-inch shaft, or 3-64 inch; which is 3-64 inch for each inch of diameter.

To find the distance *B-C* for greater or less allowance than above, first, state in a decimal form the allowance wanted per inch diameter and subtract this from 1 inch; second, look in a table of sines and cosines, down the column of cosines, till this number is found, and then look in the sine column for the sine of the same degree of angle, and it will be distance *B-C*. Example: Allowance, .0005 per inch; 1 inch — .0005 = .9995. Cosine .9995 is 1 deg. 49 min. and the sine .0317, which, × 8 inches, the shaft diameter, = .2536, or slightly over ¼ inch,which is *B-C*, or the distance the caliper point must be set in from the face of the hub.

* * *

BOOK NOTE.

Fowler's "Mechanical Engineer" Pocket Book. By William H. Fowler, Editor of the Mechanical Engineer. Scientific Publishing Co., Manchester, England. Price in England, 40 cents.

This book is pocket size and contains 324 pages. It has chapters upon steam boilers, steam engines, gas and oil engines, locomotives, electricity, chemistry and metallurgy and building materials, each written by an expert in his line of work. There are also chapters upon other engineering subjects, like lubrication, injectors, power transmission, hydraulics, etc. The quality of the contents impresses us as being good, although the work is not as complete as D. A. Low's Pocket Book, which has recently been noticed in these columns, and which is evidently the most complete English pocket book that has yet appeared. Fowler's book was prepared to sell at a low price, and contains advertising pages to help cover the expense of publication. The index is exceptionally complete. Our only adverse criticism is with regard to certain claims for the book made in the preface. For example, it is stated that the table of the properties of saturated steam given is the most complete that has yet been published. While it may be the most complete that has appeared in England, it is not nearly so complete as several American tables, notably Peabody's tables, published by Wiley & Sons, of this city. An excellent feature of the book is the fact that the several chapters are prepared by experts in their respective fields, so that the material given is probably thoroughly reliable and represents the latest and best practice in the several departments.

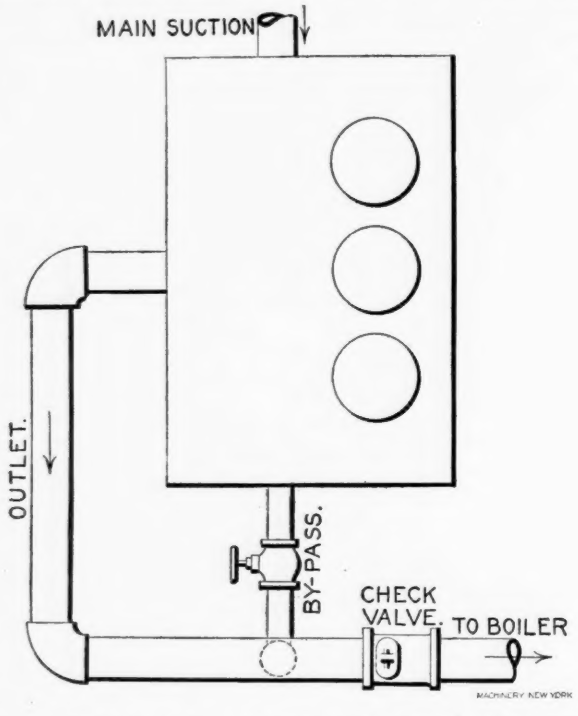
HOW AND WHY.

A DEPARTMENT INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST.

Give all details and name and address. The latter are for our own convenience and will not be published.

51. A. C. writes: Please give me cutting speeds for cast iron, machinery steel and tool steel at which lathes and planers may be calculated to run with economical results. A. Gray cast iron, 15 to 25 feet per minute; white cast iron, 5 feet per minute; machinery steel, 15 to 25 feet; tool steel, considerably slower—probably 10 to 15 feet. These are what may be considered to be average values under certain conditions. Planers generally run at from 15 to 25 feet cutting speed per minute, but in the case of lathes where any desired variation in the speed can be obtained, no general statement of speeds can be given. The quality of the stock, both in the tool and in the piece being operated upon, the feed and depth of cut that is being taken, the way in which the tool is ground and the lubricant that is used all influence the cutting speed. With self-hardening steel soft gray iron may often be turned at a speed of 40 to 50 feet per minute, and machine steel may be operated at as high or even a higher rate if the cut is not too heavy and the tool is flooded with oil, as is the case in screw machine work. On the other hand, iron or steel that is hard has hard spots or contains sand, may not allow a speed as great, even, as 15 feet.

52. X. Q. L. writes: I want to use a triplex power pump to feed my boilers with, and do not see how I can regulate the feed unless I put the belt connection on and off as the water rises and lowers in the boiler. Can you help me out? A. Put a



by-pass connection from the extra suction tap in the pump to the boiler supply pipe with a valve in it, as shown in the sketch. By opening this valve the suction is taken in good part from the pump's own outlet pipe; by closing the water is pumped into the boiler.

53. J. A. D. asks: How would you shorten the travel of the main rod of a plain D slide valve engine? It travels too far forward and back, so that the follower-plate comes over the steam port at each end of the cylinder. There are a new pair of brasses in the crosshead, and the one in the crank end is badly worn; square brasses at each end. A. The travel of main rod, or stroke, of engine can only be changed, shortened, by the crank pin being placed nearer the center of the main shaft. The distance from the center of the shaft to the center of the crank pin being in all cases one-half of the stroke, to shorten the stroke the distance should be shortened.

54. F. D. B. writes: Please explain how the governor of the Armington & Simms' engines and shaft governors of other engines operate. I understand it is done by reducing the eccentricity of the eccentric, which shortens the valve travel. What bothers me is whether the steam is cut off by the valve closing before the piston reaches the end of its stroke, or whether the valve remains open for the full stroke, and on account of its shorter travel does not allow so much steam to enter the cylinder. Another thing that bothers me is that in changing the eccentricity of the eccentric changes its throw, and also the travel of the valve. Does not the eccentric require the same time to operate the valve with the same throw as with the greater throw? And does it change the lead of the valve? A. The original Armington & Sims engine governor or regulator belongs to that class which by centrifugally acting weights operate the double eccentric which moves the valve, varying the throw or travel of the valve. At high velocity the throw of the rotary or piston valve is the least, and the cut-off by closing of valves is the shortest; at low velocity the travel or throw of valve is increased and the cut-off as late as seven-eighths of the stroke. The time for one cycle of valve motion, as well as the lead of the valve are always the same, except as influenced by the speed of the engine.

55. G. H. C. I want to cement emery cloth onto cast iron planed surface. Can you tell me of a cement that will hold the same securely? Will look for an answer in next month's issue. A. Clean the metal surface entirely free from grease, deaden the polished or smooth surface with one-third strength muriatic acid, wash entirely free from the acid and dry. Moisten the emery cloth back with nut-gall solution. Use good common glue, rather thick, by applying it to the iron, which should be warmed slightly, and spread the emery cloth over the glue, and by clamps or weights hold in close contact until dry.

56. J. M. S. I am running an ammonia compressor connected direct to a Corliss steam engine. The ammonia compressor consists of two single acting vertical cylinders, 9 inches in diameter by 16 inches stroke, with the condensing pressure 150 pounds by gauge, and the back (suction) pressure 25 pounds by gauge. The Corliss cylinder is horizontal, 12 inches in diameter by 30 inches stroke. The steam pressure is 90 pounds by gauge and the revolutions 65 per minute. The cranks are set at 180 degrees, and the connecting rod of the engine and the connecting rod of the compressor work on the same pin. The flywheel is 8 feet in diameter, but the compressor runs in jerks, and I claim that the flywheel is too light. Will you kinly inform me:

1st. How heavy should a flywheel of that diameter be, running at 65 revolutions per minute, with the pressures stated before?

2d. If we should conclude to disconnect the engine and run the compressor with a belt from a countershaft, would it be necessary to have a heavier band wheel. If so, how heavy would it have to be if 8 feet in diameter, running under the same condition as with the steam engine?

3. If we run the compressor faster or slower, would that necessitate a lighter or heavier wheel?

4th. What is the formula for figuring such things? Are there any books published on the subject?

A. 1st. If the mean effective pressure in the cylinder is, say, 60 lbs., neglecting the area of the piston rod, the horse-power developed by the engine will be

$$\text{HP.} = \frac{60 \times 2\tfrac{1}{2} \times 2 \times 254. \times 65}{33{,}000} = 150 \text{ HP.}$$

When replying to the fourth inquiry formulae for flywheels are given.

Stanwood's gives for Corliss engines, heavy duty:

$$W = 1{,}000\,000 \frac{d^2\,S}{D^2\,R^2}$$

$$W = 1{,}000{,}000 \frac{18 \times 18 \times 30}{8 \times 8 \times 65 \times 65} = 36{,}000 \text{ lbs.}$$

By Prof. Barr's formula, taking a medium constant, say,

$$\text{Weight} = 1{,}500{,}000{,}000{,}000 \frac{150}{96^2 \times 65^3} = 88{,}000 \text{ lbs.}$$

We should say that a wheel weighing from 36,000 to 40,000 pounds would be what you require, as this is borne out by calculations under answer to fourth query.

2d. You would need the same weight and diameter of flywheel as on the engine.

3d. Faster a lighter wheel, slower a heavier wheel.

4th. We append a few formulae, and can recommend "Applied Mechanics," by John Perry, and the latest book on steam engine design is the one by Jay M. Whitham.

Fly-Wheels.

One of the clearest expositions of flywheel theory is given by Perry in his "Applied Mechanics," and from it what follows is abstracted:

"The kinetic energy stored up in a wheel must be equal to a constant multiplied by the square of the number of revolutions per minute."

Suppose for experiment a wheel be mounted on an axle or shaft, and 1,000 pounds weight be hung from a rope wound around the arbor, and released when it has fallen 8 feet; it is stopped then roughly; the wheel possesses 1,000 × 8, or 8,000 feet-pounds of stored energy; if at the instant before stopping the weight the speed of the weight was 2 feet per second, we must deduct $\frac{1000}{64.4} \times 2 \times 2 = 62$ foot-pounds. If the turning was without friction and a speed of 50 revolutions per minute has been given the flywheel, then we must find a constant, M, which, multiplied by the square of the speed, or 50^2, will give (8,000 — 62), or 7,938 foot-pounds or 3.17 = M in this case.

The above rule expressed as a formula is kinetic energy = M × revolutions per minute.

To find the M of any cylindrical rotating object, we have this rule:

"Multiply the weight of the material per cubic foot by the breadth or width; multiply this by the fourth power of the diameter, and divide by the constant number 59,800."

In the book referred to the value of M is tabulated for different sections.

If, however, the wheel has a heavy rim and light spokes or arms, a close approximation of its M is found thus:

"Multiply the weight of the wheel by the square of the mean diameter of the rim," and divide by 23,000.

As to the steadiness of turning, suppose we wish the variation to be between 64 and 66 revolutions. Then the kinetic energy or KE. for each speed will be

$$KE = M \times 64^2 = M \times 4096$$
$$KE = M \times 62^2 = M \times 3844$$

And supposing that 100,000 foot-pounds is the energy needed as a reserve, then by subtracting 62^2 from 64^2 we get 252; now 100,000 ÷ 252 = 396.82, the value of the M of the required wheel. It can be proved that the comparative value of two wheels is that the "diameter of the wheels are as the fifth roots of their M's."

The exact expression for the M of a rim is thus:

$$M = \frac{w\,b\,(d^4 - d_1{}^4)}{59814}$$

all in feet, where d represents the outside diameter, d, represents the inside diameter and b the width.

Weight of rim in pounds = w.

If the outside diameter is 8 feet, for an example, not knowing any other details, will call its thickness of rim 2 inches, then to get the weight,

$$w = \frac{59814\,M,\text{ but } M = 396.82}{b(8^4 - 7{\cdot}66^4}$$

$$w = \frac{35{,}780}{b}; \text{ if } b = 1 \text{ foot, } w = 35{,}780 \text{ lbs.}$$

Nystrom in his "Mechanics" gives these formulae:

$$N = \frac{5866.5\,F\,S}{n^2\,x^2\,f}, \text{ for single acting steam engine for uniform work.}$$

$$W = \frac{2542\,F\,S}{n^2\,x^2}. \text{ for double " " " " " "}$$

$$W = \frac{1172\,F\,S}{n^2\,x^2\,f}, \text{ for double acting 2-cyl. engine for uniform work.}$$

Where

W = weight in lbs. of flywheel.
F = mean force on steam piston.
S = stroke of piston in feet.
n = revolutions per minute.
x = radius of center of gyration in feet.
f = irregularity in a fraction, of the mean revolutions N.

J. B. Stanwood, M. E., in "Ready Reference for Engineers and Steam Users":

Let

d = diameter of cylinder in inches.
S = stroke of cylinder in inches.
D = diameter of flywheel in feet.
R = revolutions flywheel per minute.
W = weight of flywheel in pounds.

For slide valve engines, ordinary duty,

$$W = 350{,}000 \frac{d^2\,S}{D^2\,R^2}$$

For slide valve engines, electric lighting,

$$W = 700{,}000 \frac{d^2\,S}{D^2\,R^2}$$

also for Corliss engines, ordinary duty.

For automatic high speed engines and Corliss engines, electric lighting,

$$W = 1{,}000{,}000 \frac{d^2\,S}{D^2\,R^2}$$

Prof. Barr, A. S. M. E., Trans., 1895, from data regarding about seventy five engines, ranging from 25 to 225 rated horsepower—American built, says: The weight of the flywheel rim in pounds varied from 341,000,000,000 ($H \div D^2, N^3$) to 2,780,000,000,000 ($H \div D^2, N^3$), and that the mean speed of the rims of the flywheels was about 4,200 feet per minute.

H = horse-power of engine.
D = diameter of flywheel in inches.
N = number of revolutions per minute.

Taylor and Wilson Co.'s "Gear Book" gives these notes on fly-wheels:

Diameter of fly-wheels on geared shafts = stroke × 3 or 4.
" " " for ropes or belts = " × 5.

Circumferential velocity for solid rims should not exceed 7,000 feet per minute; nor 5,000 feet per minute for built up rim.

It would seem that our correspondent's wheel had a failing, especially in its small diameter.

* * *

FRESH FROM THE PRESS.

PETROLEUM MOTOR CARS. By Louis Lockert. Published by D. Van Nostrand Company, New York. Price, $1.50. 218 12mo pages; illustrated.

This is a new work upon a timely subject, presenting the leading features of petroleum motor cars as they are made to-day, and discussing the mechanical details that appear in their design. The book will be appreciated by those who are investigating this new field, and it will enable them to work intelligently without threshing over the same ground that has been covered by those who have developed these carriages up to their present state of perfection, or more properly imperfection. A text book of this sort must necessarily grow old in a short time, as the development of automobiles will doubtless be rapid in the future; but it forms a very good beginning for the literature that will necessarily follow on this subject.

THE MECHANICAL ENGINEERS' POCKET BOOK. By William Kent, A. M., M. E. Published by John Wiley & Sons, New York. Fourth Edition. Revised. Price, $5.00.

The first edition of this work appeared in 1895 and was at once recognized as the best book of reference for mechanical engineers that had been published. It has since become a standard work, referred to by everybody who is in any way connected with mechanical engineering. The contents and general make-up of the book are too well known to need mention here. There are 1,100 pages treating upon every branch of the subject. The fourth edition contains many extensive alterations, much obsolete matter having been cut out and fresh matter substituted. The typographical errors that have been discovered by the author or the users of the book have been corrected. Among the subjects containing new matter may be mentioned cast iron columns, fans and blowers, flow of air in pipes and compressed air. The chapter on wire transmission has been